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NAVAL SHIP RESEARCH AND DEVELOPMENT LABORATORY Annapolis, Maryland 21402

HANDBOOK OF
FLUIDS AND LUBRICANTS
FOR
DEEP OCEAN APPLICATIONS

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HANDBOOK OF FLUIDS AND LUBRICANTS FOR DEEP OCEAN APPLICATIONS

Compiled and Edited by

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ABSTRACT

The critical factors involved in the selection of fluids and lubricants for deep ocean equipment are defined, and methods of determining critical properties are described. The values of critical properties are given for fluids and lubricants as they have been determined or are known from previous literature. Suggestions also are given on the applicability and possible limitations of the fluids and lubricants for deep submergence vehicle use. It is planned to revise and update the contents of this handbook periodically.

PREFACE

The Deep Ocean Technology (DOT) "Handbook of Fluids and Lubricants for Deep Ocean Applications" was prepared to provide critical properties, evaluation methods, and other pertinent fluid and lubricant information to designers, engineers, and operating personnel concerned with deep ocean applications.

This handbook is a "guide," not a specification. It cannot be cited as authority for action. It supplements published information and aids the user in selection of a fluid or lubricant applicable to a particular deep ocean application.

Content and Organization of the Handbook

Chapter I defines and discusses the factors involved in the selection and performance of fluids and lubricants in deep ocean applications. This chapter is written as an integrated account to be read in sequence as in a book.

Chapter II describes in detail the methods employed for establishing the fluid properties presented in Chapter III. This last chapter provides suggested applications and possible limitations in addition to the properties.

In compiling these data we have consulted many sources and utilized applicable experience wherever found. Thus, the Bibliography represents, in effect, contributors as well as source material.

Revisions, Growth, and "User Comment Return Form"

The DOT "Handbook of Fluids and Lubricants for Deep Ocean Applications" is designed to be periodically revised to include new data and considerations for fluid encapsulated system design and additional deep ocean applications. Responsibility for the maintenance and expansion of the handbook has been assigned, under the supervision of the Naval Ship Systems Command (SHIPS 03424), to the Naval Ship Research and Development Laboratory, Annapolis, Maryland.

Revisions to the handbook will be effected by the use of page changes and additions. As the handbook is published in loose-leaf form, revisions may easily be made.

PREFACE (Cont)

Using commands and individuals within the Navy and the non-military marine community are encouraged to submit additional data, paragraphs, or chapters. Less extensive feedback - even mere indications that specified sections are judged to be too general - is useful and solicited. Feedback may be forwarded directly to

Deep Ocean Technology Program
Naval Ship Research and Development Laboratory
Annapolis, Maryland 21402

Material received will be carefully reviewed and coordinated prior to publication. A handy preaddressed user comment return form is included for your convenience.

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ADMINISTRATIVE INFORMATION

This first edition of the handbook was begun by the Naval Ship Research and Development Laboratory, Annapolis, Maryland, as part of the Deep Ocean Technology Program, S4636, Task 12315, Work Unit 1-821-118-A "Fluids and Lubricants for Deep Submergence Applications." The Program Manager was the Naval Ship Systems Command (SHIPS 03424), and Naval Ship Engineering Center (SEC 6101F) was the Technical Agent. It was completed under S4636, Task 14745, Laboratory Work Unit 1-723-113-A, "DOT Compensating Systems." The Program Manager was Naval Ship Systems Command (SHIPS 03424), and Naval Ship Engineering Center (SEC 6141) was the Technical Agent.

IDENTIFICATION OF FLUID CODES

Pluid	Commercial Name	Cunnlier				
1-000	Commercial Manie	Supplier				
λ	PR-1192	E. F. Houghton Co., 303 W. Lehigh Ave., Philadelphia, Pa. 19133				
В	Micronic 713	Bray Oil Co., 3344 Madford St., Los Angeles, Calif. 90063				
С	Micronic 762	Bray Oil Co., 3344 Medford St., Los Angeles, Calif. 90063				
D	NOH-TD4-1	New Departure - Hyatt Boarings, Hayes Ave., Sandusky, Ohio 44871				
B	Hoover Sub- mersible Fluid No. 2	Hoover Electric Co., 2100 South Stoner St., Los Angeles, Calif. 90025				
P	Tellus 11	Shell Oil Co., 50 W. 50th St., New York, N. Y. 10020				
G	Tellus 15	Shell Oil Co., 50 w. 50th St., New York, N. Y. 10020				
H	Tellus 27	Shell Oil Co., 50 W. 50th St., New York, N. Y. 10020				
J	Primol 207	Humble Oil and Refining Co., P.O. Box 1288, Baltimore, Md. 21203				
K	Marcol 52	Humble Oil and Refining Co., P.O. Box 1288, Baltimore, Md. 21203				
L	SF-1143	General Electric Co., Silicone Products Dept., Waterford, N.Y. 12188				
H	C-141	Royal Lubricants Co., River Rd., Hanover, N. J. 07936				
N	PR-85-29-129	E. F. Houghton Co., 303 W. Lehigh Ave., Philadelphia, Pa. 19133				

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INTRODUCTION

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In the typical U. S. Navy submarine, most of the operating machinery for propulsion, maneuvering, and other required functions is located within the pressure hull. In contrast, only the control equipment of deep submergence vehicles is housed within the pressure capsule. It is connected by wires through glass-to-metal seals through the capsule to external machinery. Thus, only electrical control signals are provided to pumps, motors, winches, hydraulic systems, and the other required machinery operating in the ambient pressure, temperature, and contaminants of the deep ocean.

To shield system components from the corrosive action of seawater and other effects of the ocean environment requires that equipment be operated within some sort of protective medium. Three approaches are being pursued: (1) encapsulation, (2) the "hard shell," and (3) fluid compensation. Encapsulation of components in a material such as epoxy resin is under investigation. As an alternative, the sealed case, or "hard shell," is not always applicable. Its disadvantages are the size and weight required to withstand the pressure of the deep ocean environment, means to achieve adequate neat transfer, and the problem of penetrations that can withstand high-pressure differentials. A fluid-filled, pressure-compensated case for these components external to the pressure hull has been the preferred protective approach. This is the alternative that requires consideration of suitable protective fluids.

CHAPTER I FLUID AND LUBRICANT PROPERTIES AND USE CLASSIFICATION

The exploration of the ocean depths has created requirements for fluids and lubricants for which no precedent exists. The hostile environment of the ocean, and not necessarily the sophistication of the equipment, has placed new demands on fluids and lubricants. Fluids will have to withstand exposure to ambient temperatures ranging from 28° to 130° F, pressures up to 20,000 psi, and a chemically corrosive environment.* Undersea exploration is being performed by means of manned and unmanned submersibles, with externally placed pressure-compensated machinery, manned submerged habitats, and submerged instrument packages, each of which may have fluid or lubricant needs.

Generally speaking, there are three main uses for fluids and lubricants in deep ocean applications:

- Power transmission; i.e., the fluid for a hydraulic system.
- Lubrication; i.e., friction and wear reduction for system bearings and gears.
- Shielding from environment; i.e., a fluid to fill externally placed electric motors, switches, and relay boxes, to protect the components from seawater.

Ideally one fluid could serve all three purposes, but most fluids will not be suitable for all three.

Furthermore, it must be remembered that when products purchased under a military or federal specification are used, properties not specifically required by the specification may vary widely from one manufacturer to another and from one manufacturer's batch to another.

Viscosity

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Viscosity is one of the most important single properties of any fluid that is to be used for power transmission or for lubrication. In surface vessels, submarines, and aircraft, viscosity

^{*}Abbreviations used in this text are from the GPO Style Manual, 1967, unless otherwise noted.

is no longer a serious problem, since representatives of the various types of hydraulic fluids and lubricants are available in suitable viscosities, and with improved additives to yield very favorable viscosity/temperature relationships. While the effect of temperature is still the major consideration, a new variable, introduced with deep submergence, the viscosity/pressure relationship, is superimposed on the temperature effect.

In nearly all planned uses, as many components as possible are placed external to the pressure hull where the fluid serves as a protective medium for the mechanical and electrical system components and, of course, is subjected to the ambient pressure at the dive depth. Moreover, the fluid in a hydraulic system is usually pressurized to 3000 psi above the ambient pressure to operate the system components. Such systems could subject the fluid to a total of 20,000 psi at the maximum known depth of the ocean.

It is well known that viscosity increases with pressure. The viscosity of pure petroleum oils may increase as much as 30 times at a pressure of 20,000 psi. The viscosity of petroleum oils with polymeric additives that improve the viscosity index exhibits an increase of only 10-15 times the atmospheric pressure value. Silicone oil of low viscosity increases 8-10 times in the same range. Several mathematical relationships for predicting the increase of viscosity with pressure have been studied. The best representation has been obtained from a third-order polynomial expansion of the logarithm of viscosity at pressure which agrees with measured values to within 1%; i.e.,

$$ln_U = ln_{U_Q} + bp + cp^3 + dp^3$$

where

v = viscosity at the measured pressure

U_O = viscosity at atmospheric pressure

p = pressure

b = coefficient characteristic of the fluid measured

c = coefficient characteristic of the fluid measured

d = coefficient characteristic of the fluid measured.

(A straight-line fit logarithm of viscosity versus pressure data, $4n_U = 4n_{U_Q} + bp$, will predict values to within 10% of the measured values. The coefficients of the equations are characteristic of the fluid measured.)

The pressure/viscosity relationship imposes a new restriction on the choice of fluids. The information available at the present time offers some guidelines upon which to base a selection:

- Lower viscosity fluids are less affected by pressure than higher viscosity fluids.
- Low viscosity permits higher speeds in electric motors.
- The viscosities of gas-saturated fluids are less affected by pressure than are those of the gas-free fluids.
- Additives which improve the viscosity/temperature relationship appear to significantly reduce the viscosity change due to pressure increase.
- Low viscosity has also been shown to be a desirable characteristic of fluids used in the satisfactory operation of switching electrical devices in fluids under high pressure. The failure of electrical devices due to the buildup of solid products or "clinkers" between contact surfaces in pressure compensating fluids takes place less readily, the lower the viscosity of the fluid.

The addition of polymeric viscosity index improvers offer an attractive possibility for alleviation of both temperature and pressure effects on viscosity. These materials render a fluid non-Newtonian; that is, its viscosity becomes dependent upon the shear-rate condition to which the fluid is subjected. The system designer must take into account that the apparent viscosity of a non-Newtonian fluid in a system with a high shear rate will be significantly lower than the viscosity measured by conventional laboratory viscometers. The same shear which lowers the viscosity of the fluid, due to its non-Newtonian behavior, has the undesirable property of eventually degrading the viscosity-improving additive (a polymer of high molecular weight) by reducing its molecular weight, thus permanently reducing the viscosity of the fluid.

Viscosity may be an important consideration for fluids which are intended to provide environmental protection for nonmoving electrical and electronic components. There are indications that in the event of sea-water contamination, all other things being equal, fluids of higher viscosity have a greater tendency to keep water in suspension, a characteristic which lowers the dielectric breakdown voltage and insulation resistance of the fluid to unacceptable levels.

Low viscosity may also be desirable in relation to electrical equipment, from the standpoint of heat transfer. The lower the viscosity of the fluid, the more rapid will be the desired dissipation of heat generated by motors, switches, solid-state devices, and other electrical components.

Lubricating Ability

The lubricating ability of a fluid or lubricant is a critical consideration in the selection of an immersion medium for moving parts. While viscosity has been separately discussed as a critical property, it also affects lubricating ability. The present requirement for lubrication of moving parts under deep submergence pressure, when considered in the light of the properties of known lubricants, dictates the use of low viscosity fluids. On the other hand, such fluids present serious lubrication problems at atmospheric pressure. A fluid for deep ocean use will have its highest viscosity at the maximum operating depth and thus at the lowest ambient temperature. It will also have its lowest viscosity while operating on the surface or at its shallowest operating depth, where the ambient pressure is at a minimum and ambient temperature is at the maximum. Thus, a fluid may have adequate viscosity for lubrication over most of a machine's operating depth; yet when the machine is operated on the surface, its viscosity may be below acceptable levels for good lubrication. Conversely, a machine may have good efficiency due to low viscosity when operating near the surface and have poor efficiency due to high viscosity when operating at maximum depth. In applications where viscosity is an important factor (motors, gears, and hydraulic systems) it is necessary to consider these operating extremes. A fluid whose viscosity shows a small variation with pressure and temperature and has good lubricating properties would be desirable for that machine. However, in most instances, today, a tradeoff must be made since fluids with these ideal properties do not exist for all required applications.

A similar set of requirements was encountered in "Aerospace" applications where low visconity lubricants had to be employed due to the extremely low hemperature of the operating environment. The solution to the problem was to develop additives to improve the load-carrying ability (i.e., the ability of a lubricant to maintain a film between two moving metal components preventing metal-to-metal convect, duspite extremely high pressures), to develop additives to improve the viscosity/temperature relation, and to develop additives to keep the lubricants from oxidizing from the heat generated by less-than-satisfactory lubrication. In addition to the development of lubricants, changes were made in design of the equipment to make it tolerate the low viscosity lubricants. Furthermore, the nature of the application made the relatively short running time and short equipment life acceptable.

"Aerospace"-type lubricants are currently in use in both Navy and commercial deep submergence vehicles. While they have proved satisfactory for present short-term operations, improvements are required for reliable long-term operation in the pressure range expected in the deep ocean environment.

Effects of Contamination

It is well known that water in a lubricant reduces the life of loaded rolling angular-contact bearings by accelerating rolling-contact fatigue failure. Water in a lubricant also alters its rheological properties which ultimately affect its lubricating ability for gears and sliding contacts.

Solid contaminants in the lubricant act as abrasives to increase the wear on moving parts, and if solid particles are present in sufficient quantities, the filters and valves in moving systems may become clogged and fail to operate as designed.

The acceptable limits of both sea-water and solid contamination have not been established.

Corrosion Protection

Fluids and lubricants for deep ocean uses must provide protection from the corrosive character of the environment, seawater. The fluid or lubricant must be capable of protecting the system from corrosion, for seawater has a high probability of entering the system.

Rust-inhibiting fluids and lubricants of many types have been available for years and are available in the low viscosity types required for deep ocean applications. However, the ability ofmany fluids to inhibit corrosion has, in the past, been evaluated chiefly in terms of the rust prevention of ferrous metals. To depend on such fluids may be hazardous since there are also nonferrous metals in all deep submergence systems. It is not always possible to use the fluid which has given maximum protection to a mild steel specimen in a laboratory test, since there are numerous examples of rust-inhibited fluids which severely attack nonferrous metals. The specifications of fluids for corrosion inhibition should be prepared, or revised, so that uniform protection is provided for all the metals encountered in the various systems.

A fluid which is to be used for any of the three main functions - power transmission, lubrication, environmental protection - must display the ability to protect all system metals from corrosion. This is a property which must be continually improved so that system components are protected from all forms of corrosion, that is, stress, galvanic, crevice, and pitting, as well as general chemical attack by the action of seawater.

Dielectric Properties

A pressure-compensating fluid for electric motors, relays, switching devices, and electronic equipment must have good dielectric properties and ideally should be otherwise inert to the effects of electrical equipment operation.

The dielectric quality of a fluid is measured in terms of electrical resistivity, dissipation factor, and dielectric breakdown voltage. Dielectric properties of a fluid as received result from its chemical nature and from the presence of additives in certain cases. In practice, several factors affect dielectric properties during usage.

Contamination of the fluid by sea-water leakage is an important cause of failure. As little as 0.1% contamination by seawater reduces the resistivity of some fluids below suggested limits. Fluid chemical changes and carbon produced by arc discharge through the fluid or from brush wear also lower its resistivity and breakdown voltage below suggested limits. Equipment failures due to lowered resistivity and dielectric breakdown voltage also have been caused by contamination with metallic

particles resulting from the wear processes of moving parts. A commonly observed failure at high pressures and high current densities of fluid-compensated electrical switching devices is the deposition of carbon or silica on electrical contacts, where arcing occurs. At present no fluid has been found that can provice long life under these conditions.

Dissipation Factor

The need for fluids and lubricants with corrosion protection properties and improved lubricating ability has led to the formulation of products which contain polar additives and those in which water is soluble or with which water is miscible. addition to lowering the resistivity and dielectric breakdown voltage, the polar materials also decrease the efficiency of an electric motor by transformation of electrical energy into heat energy in a nonsinusoidal alternating-current system. useful measure of this property is the dissipation factor of the fluid. A high dissipation factor predicts dielectric heating losses. Dissipation factor is defined as the tangent of the loss angle expressed as percent for a dielectric material. (A perfect insulator would have a loss angle of 0 degree and thus a dissipation factor of 0%.) Dielectric heating losses are proportional to the square of the voltage gradient, frequency of applied voltage, dielectric constant, and dissipation factor. The trend in submersible equipment is to use inverters and choppers, without filters to save weight; thus, high frequencies are encountered. It then becomes obvious that dielectric losses through the fluid will increase if the dissipation factor of the immersion fluid is high or if it increases due to contamination. The losses would not be immediately obvious in laboratory bench studies where commercial electric power is the energy source. In actual naval service unfiltered inverters and choppers with a large percentage of high-frequency component are used. Evaluation methods which consider this operating condition have not been devised.

Ability to Form Stable Emulsions

When the fluid encapsulating any electrical equipment becomes sea-water contaminated, it is clear from the statements in the preceding paragraphs on dielectric properties that efficiency may be lost or failure may occur. The quantity of the seawater in the fluid and its state of subdivision may determine whether failure or efficiency losses will occur. This factor is especially important in the operation of electric motors where motor shaft seals may allow leakage of the external seawater. If the oil

permits the water to separate in large drops, a short circuit and catastrophic failure can occur when one of the drops of seawater bridges the electrical gap. If, on the other hand, the water is emulsified in extremely small droplets, the motor may still operate, even though dielectric heating and loss of efficiency may occur. In this case, even though emulsified water in the immersion fluid may ultimately lead to motor failure, the failure is not of the catastrophic type. Present methods of evaluation of emulsifying ability have not yet been correlated with perfermance capability. The limits of emulsified water in oil and the limits of polar-type emulsifiers have not been established, nor has the use of nonpolar emulsifiers been investigated. These considerations are not so important in electrical components other than motors where little agitation occurs.

Material Compatibility

The use of compatible materials in a system which is to be fluid-filled is of prime importance regardless of the fluid used. No system should be designed without considering the compatibility of the fluid and material. When a fluid is selected, a list of compatible materials should be compiled or consulted to determine whether the metals, coatings, insulations, seals, and elastomers in the system are compatible. If a specific material is required for a particular application, then the fluid selection must be governed by its compatibility with that material. Incompatible coatings or elastomers may cause the formation of sludge in the fluids. System leaks can develop when incompatible elastomers are used for sealing. Electrical failures can result from the use of incompatible fluids and insulating materials. Accelerated corrosion usually results when a fluid is in contact with an incompatible metal.

Volatility and Toxicity

These two related properties require consideration for any fluid or lubricant application. Nearly all volatile materials pose a certain degree of toxicity, but not all toxic liquid materials are volatile. The toxicity may be exhibited in various ways. Volatile materials may affect lungs, bronchi, and masal passages either by irritant action, by chemical or solvent action on tissue, or by forming an inert coating to interfere with the respiratory process. Toxic liquids in contact with the skin or eyes cause irritation, destruction of tissue by chemical action, or dematitis, in sensitive individuals. Inert liquids such as silicone oils, which are not considered toxic in the

usual sense of the word, present special problems when they get in the eyes or are inhaled. Their insolubility and immiscibility with water make it impossible for body fluids to carry them away, and in the case of the eye, a condition similar to cataract can result. In most cases, fluids and lubricants used in deep submergence will be volatile and toxic. Such use, however, will be in capsules external to the pressure hull of manned vehicles. The breathing atmospheres of manned habitats will have to be reviewed, particularly from the standpoint of sources of fluid vapors or solid lubricant dust. The volatility of all solid and liquid lubricants should be specified properly for all deep ocean applications. The effect of pressure should be included since in most cases volatility increases with pressure.

Compressibility and Density

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Ideally a liquid is incompressible, but existing fluids and lubricants show 5%-7% decreate in volume in the case of petroleum fluids, and 8%-13% in the case of silicone-base fluids when they are in the pressure range from atmospheric to 20,000 psi. Fluid-encapsulated systems must be designed to allow sufficient fluid to ensure that the system components will be lubricated and protected from the environment in spite of any volume reduction in the fluid. Compressible liquids can cause some operational sluggishness if they are employed in a hydraulic system.

It is desirable to have liquids with a density less than 1.0 gram per cc at atmospheric pressure since this will save weight in the system. All of the petroleum oils and most of the applicable silicone oils have a density of less than 1.0 at atmospheric pressure. The more inert classes of liquids all have high densities and are not being generally utilized for that reason. Since there is an increase in density with an increase in pressure and the weight of the fluid head will change, the circulation rate may decrease for fluids or lubricants which are pump-circulated. The density as well as the compressibility of fluids as a function of both temperature and pressure should be considered by vehicle and machinery designers.

Chemical Stability

The term "chemical stability" is used here to indicate the ability of a fluid or lubricant to resist oxidative, hydrolytic, or thermal degradation. Failure of a fluid or lubricant to resist oxidation or hydrolysis creates a hostile environment for the system components even in the absence of contamination. Such

breakdown results in the formation of studge and fluid viscosity changes which can promote wear and impair system operation. In the case of oxidation or hydrolysis, organic acids are formed which can be corrosive to system metals. Such breakdown of fluids and lubricants is considered normal and likely to occur in any type of service to various degrees. The problem of arcs caused by the make and break of electrical contacts has already been discussed under dielectric properties. Under high pressure and high current densities an electric are will cause the formation of large particles of carbon and silica. In some cases these particles bridge the gap between electrical contacts preventing complete interruption of the circuit.

All fluids (hydrocarbons and silicones) tested thus far under electrical arcing also produce gaseous decomposition products. The accumulation of gaseous products in a pressure compensator, under submerged conditions, presents the problem of possible rupture of compensating chamber walls, or flexible membranes, on surfacing. Since sizable quantities of gas have been observed under experimental conditions, a means of safely bleeding off gases while surfacing will be required.

Accurate figures on the rate of gas production under various arcing conditions are not available.

Oxidation resistance, arc-breakdown resistance, and thermal-breakdown resistance tests and standards have not been developed to provide selection criteria for fluids and lubricants.

Fire Resistance

Fire hazards exist in hydraulic systems, air compressor systems, and fluid-lubricated systems which are located inside the pressure hull of a submersible; in such cases care must be taken to eliminate air from the system and prevent overheating to reduce the fire hazard. Care must always be taken to prevent fire while draining or filling any system using a combustible fluid. The low viscosity fluids for deep submersibles are more readily ignited than the fluids used on surface ships and conventional submarines; greater precautions must be taken to prevent ignition. Petroleum oils and silicone oils are both relatively easily ignited. Fluids with flash points below 300° F should be treated with extreme care. Suitable published precautions should be observed. The more fire-resistant fluids and lubricants are among the inert fluids having densities which are too high for consideration.

Cost and Availability

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The small volume and specialized nature of the deep ocean systems have caused the designers to consider the cost factor of fluids as secondary. Fluid availability has been the principal consideration. The petroleum-based fluids are usually readily available and procurable in drum quantities at a reasonable cost. The specially purified aerospace oils are moderately expensive. If and when fluid cost becomes a problem, the use of the relatively expensive silicone fluids will have to be limited to critical application. Specially developed new fluids will be expensive due to high development and testing costs and because the limited market for deep ocean applications at the present time will not encourage large volume production and competition which tend to reduce costs.

This chapter has attempted to define and discuss the factors involved in the use of fluids and lubricants in deep ocean applications. At the time of writing, the above selection and definitions of the critical properties are those which appear to be the main factors to consider in the selection of a fluid or lubricant for use in a deep ocean application. It is the intent to revise this handbook on an annual basis. When it is established that a new consideration is needed, it will be added. As items prove to be noncritical they will be deleted.

CHAPTER II METHODS FOR ESTABLISHING FLUID PROPERTIES

The methods described in this chapter have all been developed especially for the conditions of deep ocean applications, and sea-water and solid contamination anticipated for fluids and lubricants in deep ocean equipment. These methods are in various states of development, and as yet limits have not been established for all methods. Ratings in some cases are still on a comparative basis. Standard methods, such as those described by the American Society for Testing and Materials (ASTM), Federal Test Method Standard No. 791a, and the Society of Automotive Engineers (SAE) Aerospace Recommended Practices (ARP), are not described in this chapter. Procedures described in detail by other reports will be referenced when data are presented in Chapter III. The methods described in this chapter are tentative and may have published counterparts which would be preferable. The results of these methods will be compared with the published methods in the future if any are found to exist. All methods and data will be reviewed periodically and replaced or updated in subsequent revisions.

CORROSION AND COMPATIBILITY PROCEDURES

Cl. Ambient Pressure Stirred Corrosion Procedure

Scope - This method conducted at atmospheric pressure is intended to measure the relative protection provided by fluids and lubricants to metals and alloys used in deep submergence components when exposed to contamination by seawater.

Outline of Method - A sample of oil in a glass beaker is brought to a predetermined temperature in an oil bath. Corrosion specimens isolated from each other are mounted on a metal rod which is then stirred in test oil. Seawater is added to the test oil. After the desired exposure period, the specimens are cleaned, dried, weighed, and photographed to measure degree of corrosion.

Apparatus

- a. The heating bath, stirring motor and assembly, beaker and beaker cover are the same as those used in ASTM (Method) D-665.
- b. A 304 stainless steel rod, 9 1/2 inches long and 1/4 inch in diameter, with 4 1/2 inches of 1/4-inch 20 threads in one end is substituted for the ASTM D-665 stirrer. Stainless steel nuts (304) (1/4-inch 20) are used to hold specimens on the rod.
- c. Spacers for specimens shall be made of polytetrafluoroethylene (PTFE). They shall be cut from 1/4-inch inside diameter (ID), 3/8-inch outside diameter (OD) tubing and shall be 1/8 inch thick.
- d. Corrosion specimens shall be 1 x 1 x 0.032 inch with a 1/4-inch hole in the center. The specimens shall have a finish (before polishing) conforming to Federal Test Method Standard No. 791a, Method 5308.4. The specimen shall be of any alloy or metal used in the deep submergence components. Those used by NAVSHIPRANDIAB, Annapolis are shown in Figure 1. A typical specimen rod assembly is shown in Figure 2.

HAVAL SHIP RESEARCH AND DEVELOPMENT LABORATORY

STEEL, Stainless, Type 316

ALUMINUM 6061, Specification QQ-A-250-11

COPPER-NICKEL, 70-30, Specifications MIL-C-15726 or MIL-T-00/6420

STEEL, QQ-S-698, Grade 1009

ALUMINUM, QQ-A-250-4b

COPPER, QQ-C-576a

NICKEL-COPPER, QQ-N-281, Class A, Monel 400

BRONZE, MIL-B-16541A(WEP) (1/16 inch thick)

PHOSPHOR-BRONZE, QQ-B-750, Composition A

SILVER BASE BRAZING ALLOY, MIL-B-15395A, Grade IV

STEEL, Galvanized, Electrodeposited, QQ-Z-325A, Type II, Class I

Specification for Items Above

Metal Specimens, 1 x 1 x 0.032 inch with a 1/4-inch hole in center, finish to conform to that given in Federal Test Method Standard No. 791a, Method 5308.4

Figure 1 (C1)
Specimens Used

NAVAL SHIP RESEARCH AND DEVELOPMENT LABORATORY

- 1 Copper
- 2 316 Stainless Steel 3 Copper-Nickel, 70-30

- 6 Galvanized Steel

- 7 = Steel, 1009
- 8 = Aluminum, QQ-A-250-11
- 9 Bronze
- 3 Copper-Nickel, 70-20
 4 Aluminum, 00-A-250-4b
 5 Phosphor, Bronze
 10 Monel
 11 Silver Base Brazing Alloy

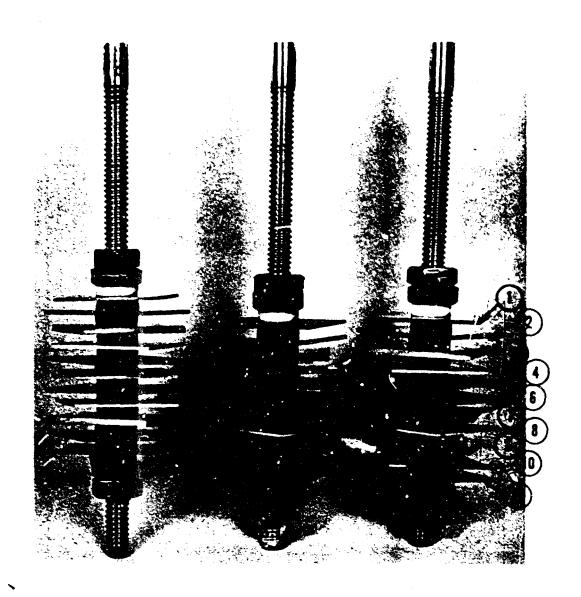


Figure 2 (C1)
Typical Specimen Rod Assembly

Materials

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- a. Naphtha solvent conforming to ASTM-D-91 method.
- b. Freon TF solvent-trichlorotrifluoroethane obtained from
 E. I. du Pont de Nemours and Company.
 - c. Aluminum oxide polishing compound, 150 grit.
 - d. Seawater, ASTM D-665.
- e. PTFE tape, 1/2-inch wide, Scotch Brand No. 48 obtained from Minnesota Mining and Manufacturing Company.
 - f. Typewriter brush, Federal Specification H-B-00681C.

Preparation of Corrosion Specimens

- a. Handle specimens with disposable polyethylene gloves.
- b. Flush with naphtha to remove preservatives.
- c. Polish with 150 grit aluminum oxide powder on medicinal cotton wads (do not polish plated specimens).
 - d. Make polish strokes in one direction.
- e. Turn specimen 90° and polish until previous polish marks are removed.
 - f. Brush with camel hair brush.
- g. Use wash bottle to flush specimens with jet of naphtha then with Freon TF.
 - h. Air dry and place in desiccator.
 - i. Weigh on semimicrobalance; record weight to 0.00001 gram.

Procedure

- a. Place 270-ml test oil in a clean beaker. Heat in an oil bath to 140° F.
- b. Clean the specimen rod with soap and water, then with distilled water and oven dry at 220° F.

- c. Wrap the rod with PTFE tape to insulate from specimens.
- d. Assemble specimens as shown in Figures 1 and 2. Use clean polyethylene gloves to handle specimens and rod. Separate specimens from each other and end nuts using the PTFE spacers. Secure with nuts on both ends.
- e. Insert the rod assembly in stirring device with specimens in oil and beaker cover in place.
 - f. Stir for 1 hour.
- g. Add 30-ml ASTM D-665 seawater while stirring. Plug excess holes in the cover with inert material, such as glass plugs.
- h. Inspect the fluid level daily and add distilled water to make up for losses by evaporation.
- i. At the end of the test period remove specimens and store in naphtha prior to cleaning.
- j. Clean the specimens by successive flushes with naphtha and brushing with a naphtha-wet typewriter brush.
- k. Make a final flush with Freon TF; then place the specimens in a desiccator to condition prior to weighing.
- 1. Record weight changes and changes in appearance of specimens by written descriptions and photographs.

Scope - This method is intended to measure the effects of cycled-pressure on deep submergence fluid compatibility with materials of construction.

Outline of Method - A high-pressure reaction vessel, filled with a temperature and pressure-transfer oil, is brought to a test temperature of 140° F. A test cell consisting of metallic or nonmetallic compatibility specimens immersed in the oil being studied contained in a PTFE bag is immersed in the transfer oil. The reaction vessel is closed. The maximum selected test pressure is applied to test assembly via the transfer oil and then returned to ambient pressure over a 30-minute cycle. The test temperature and pressure cycling are maintained throughout the test period (usually 30 days). At the end of the test, specimens and fluid are examined for evidence of physical and chemical changes and performance properties.

Apparatus

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- a. Reaction vessel The reaction vessel shall have 4-inch ID and 16-inch useful height. It shall have a 3300-ml capacity. The top shall have fluid inlet and outlet ports and a thermocouple well.
- b. Test cell The fluid specimens are contained in a PTFE cylindrical bag (3-inch ID, 8-inch-long) with 304 stainless steel end closures. (See Figure 1.)
- c. Specimen holder The specimen holder shall be of any design suitable to hold specimens in fluid with ample space between specimens and between test cell wall and specimens. It shall be of 304 stainless steel. A typical holder for metal specimens is shown in Figure 2.
- d. Spacers The spacers shall be made of either 304 stainless steel or PTFE. They shall be cut from 1/4-inch ID, 3/8-inch OD tubing and shall be 1/8 inch thick.
- e. Constant-temperature bath The constant-temperature bath shall contain MS 2190-TEP petroleum oil as the heating medium. It shall be designed to permit immersion of the reaction vessel up to the lower rim of the locking nut. The bath shall be capable of maintaining the vessel and transfer oil at any temperature between 100° and 250°±2° F. During pressure cycles, the test oil temperature varies, for example, at the selected pressure, transfer oil temperature will vary from the set temperature of 140° F, as the pressure is released and applied, from 125° to 155° F.

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Figure 1 (C2) Test Cell



Figure 2 (C2)
Typical Metal Specimen Holder

- f. Pressure supply The pressure shall be supplied by a high-pressure pump, such as a 30,000 psig Sprague diaphragm pump, Model S-216-CPR-300. All tubing and fittings shall be high-pressure 304 or 316 stainless steel. The pump controls shall be capable of linearly cycling the pressure in the reaction vessel from 0-20,000 psig and back to 0 psi over a 30-minute period, with a variation of ±200 psig. A schematic diagram of the pressure supply is shown in Figure 3.
- g. Recording potentiometer A recording potentiometer capable of recording oil temperatures from 100° to 250°±2° F shall be used.

h. Specimens

- (1) Metal specimens shall be of any deep submergence alloy or metal to be studied. The size shall be $1 \times 1 \times 0.032$ inch with a 1/4-inch hole in the center. The specimens shall have a finish (before polishing) conforming to Federal Test Method Standard No. 791a, Method 5308.4. The metals used by NAVSHIPRANDLAB Annapolis are given in Figure 4.
- (2) Nonmetallic specimens shall be of any deep submergence elastomer, plastic, or insulating material contacting fluids of interest. Where possible, specimens shall be prepared in a Type C dumbbell shape as in ASTM D-412-66.

Materials

- a. Naphtha solvent, conforming to ASTM D-91 method.
- b. Freon TF solvent, trichlorotrifluoroethane, E. I. du Pont de Nemours and Company.
 - c. Aluminum oxide polishing compound, 150 grit.
 - d. Seawater, ASTM D-665.
- e. PTFE tape, 1/2-inch-wide, Scotch Brand No. 48, Minnesota Mining and Manufacturing Company.
 - f. Typewriter brush, Pederal Specification H-B-00681c.
- g. Temperature and pressure transfer oil = MIL-L-17331, MS 2190-TEP.

NAVAL SHIP RESEARCH AND DEVELOPMENT LABORATORY A - Air Driven Pump (rated 30,000 psig) H' - Check-Valve (10 psig working B - Pump reservoir (capacity 3 gallons) pressure) C - Pupture Assembly (set 22,500 psig D - Pressure gage (25,000 psig) - Solenoid Valve (110 vac) - Bleed-Down Sump (1 quart) E - Air Operated, Flow Control Valve - Support Stand (30 x 36 x (50,000 paig) 40 inches) F - Pneumatic Indicating Controller - Heated Oil Bath (20 gallons, (100 peig) 140° F. 2130-TEP) G - Microset Hand Valve - Reaction Vessel (3300-ml, H - Check-Valve (40 paig working rated 30,000 psig at 125° F) pressure) - Thermocouple All high-pressure tubing - 1/4-inch 00, 1/16- or 3/32-inch 1D, rated 60,000 paig. All valves, tees, elbows - rated 30,000 paig (superpressure). Auxiliary Equipment (Not Shown) High-Speed Bath Stirrer Immersion heaters (1500 watts) Bath Temperature Control Recording Potentiometer Air Operated Cycling Device Electric Timer Air Filters, Regulators, etc

Figure 3 (C2) - Cycling Unit

NAVAL SHIP RESEARCH AND DEVELOPMENT LABORATORY

STEEL, Stainless, Type 316

ALUMINUM 6061, Specification QQ-A-250-11

COPPER-NICKEL, 70-30, Specifications MIL-C-15726 or MIL-T-00/6420

STEEL, QQ-S-698, Grade 1009

ALUMINUM, QQ-A-250-4b

COPPER, QQ-C-576a

NICKEL-COPPER, QQ-N-281, Class A, Monel 400

BRONZE, MIL-B-16541A(WEP) (1/16 inch thick)

PHOSPHOR-BRONZE, QQ-B-750, Composition A

SILVER BASE BRAZING ALLOY, MIL-B-15395A, Grade IV

STEEL, Galvanized, Electrodeposited, QQ-Z-325A, Type II, Class I

Specifications for Items Above

Metal Specimens, 1 x 1 x 0.032 inch with a 1/4-inch hole in center, finish to conform to that given in Federal Test Method Standard No. 791a, Method 5308.4

Figure 4 (C2)
Metal Specimens Used

Preparation	of Sample	Container	and Spec	imen Holder
				صحت المستحد

a. The PTFE bag, end pieces, and specimen holder shall be successively washed with ASTM D-91 naphtha, scap and water, and distilled water; then oven dried at 140° F.

Preparation of Specimens

- a. Metallic specimens shall be cleaned, polished, and weighed as in the "Ambient Pressure Stirred Corrosion Procedure," Method Cl.
- b. Normetallic specimens shall be prepared, cleaned, and volume measured as in ASTM D-471-66.
- c. The specimens shall be attached to the specimen holder so as to provide space between the individual specimens and also between the specimens and the wall of test cell so that all parts of specimen are flooded by test fluid. Where insulated metallic specimens are used, the order of assembly shall be as given in Method Cl. When metallic couples also are to be studied, the order of assembly shall be as shown in Method C4 ("20,000 MIG Stirred Corrosion Procedure"), except that the insulated specimens shall be placed on the specimen holder above the coupled specimens.

Procedure

- a. Bring reaction vessel and transfer of oil to test temperature.
 - b. Assembly of test cell.
- (1) The PTFE bag is fitted into the bottom and top closures.
- (2) The specimen assembly is inserted into the bag through a removable part of top closure placed on the bag.
- (3) The cell is filled with 825 ml of test fluid through the top port, taking care to purge out the air. The top port is closed.
- (4) Get the total weight of the test cell. The test cell is again weighed after the test period. The weights are obtained to determine whether the test cell leaked during the test.

- c. Place the test assembly in the reaction vessel in transfer oil.
- d. If sea-water contaminant is to be used, allow the test cell to remain in the reaction vessel for 1 hour. Then remove the test cell from the reaction vessel and add seawater through the top port. Close the top port and return the test cell to the reaction vessel.
- e. Close the reaction vessel, placing the thermocouple end at the top of the test cell.
- f. Add sufficient additional transfer oil to finish filling the reaction vessel and purging out the air. Close the reaction vessel.
- g. Begin pressure cycling and maintain pressure cycling and test temperature for the test period.
 - h. At the end of the test period remove the test cell.
 - i. Separate the specimens and the test oil.
- j. Measure the properties of the test oil to detect changes (viscosity, acid content, density, metal content, etc).
 - k. Measure changes in the specimens.
 - (1) Clean and weigh the metal specimens as in Method Cl.

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(2) Determine volume, hardness, tensile strength, and elongation changes in the nonmetallic specimens as in ASTM D_471-66.

C3. 20,000 PSIG Static Compatibility Procedure

Scope - This method is intended to measure the effects of pressure on deep submergence fluid-material compatibility.

Outline of Method - A high-pressure reaction vessel, filled with a temperature-pressure transfer oil, is brought to a test temperature of 140° F. A test cell, consisting of metallic or non-metallic compatibility specimens immersed in the oil being studied contained in a PTFE bag, is immersed in the transfer oil. The reaction vessel is closed, and the test pressure, 20,000 psig maximum, is applied to the contents of the reaction vessel. Temperature and pressure are maintained constant throughout the test period. At the end of the test the specimens and the fluid are examined for evidence of physical and chemical changes and performance properties.

Apparatus

- a. Reaction vessel The reaction vessel shall have a 3 1/2-inch ID and a 12-inch useful height. It shall have approximately a 2000-ml capacity. The top shall have fluid inlet and outlet ports and a thermocouple well.
- b. Test cell The fluid and specimens are contained in a PTFE cylindrical bag with 304 stainless steel end closures as shown in Figure 1.
- c. Specimen holder The specimen holder shall be of any design suitable to hold specimens in the fluid with ample space between specimens and between the test cell wall and specimens. It shall be or 304 stainless steel. A typical holder for metal specimens is shown in Figure 2.
- d. Spacers Spacers shall be made of either 304 stainless steel or PTFE. They shall be cut from 1/4-inch ID, 3/8inch OD tubing and shall be 1/8-inch-thick.
- e. Constant-temperature bath The constant-temperature bath shall contain MS 2190-TEP petroleum oil as heating medium. It shall be designed to permit immersion of the reaction vessel up to the lower rim of the locking nut. The bath shall be capable of maintaining the vessel and tranfer oil at any temperature between 100° and 250°±2° F.

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Figure 1 (C3) Test Cell

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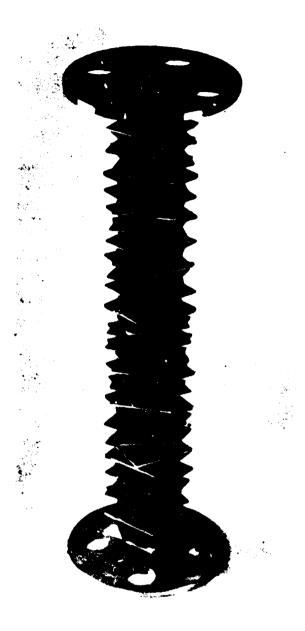


Figure 2 (C3) Specimen Holder

- f. Pressure supply The pressure shall be supplied by a high-pressure pump, such as a 30,000 psig Sprague diaphragm pump, model 8-216-CPR-300. All tubing and fittings shall be high-pressure 304 or 316 stainless steel. The pump shall be capable of maintaining the test oil at 0-20,000±25 psig. A schematic of the system is shown in Figure 3.
- g. Recording potentiometer A recording potentiometer capable of recording oil temperatures from 100°-250°±2° F shall be used.

h. Specimens

- (1) Metallic specimens shall be of any deep submergence alloy or metal to be studied. The size shall be $1 \times 1 \times 0.032$ inch with a 1/4-inch hole in the center. The specimens shall have a finish (before polishing) conforming to Federal Test Method Standard No. 791a, Method 5308.4. The metals used by MAVSHIPRANDIAB, Annapolis are given in Figure 4.
- (2) The normetallic specimens shall be of any deep submergence elastomer, plastic, or insulating material contacting fluids. Where possible, specimens shall be prepared in a Type C dumbbell shape as in ASTM D-412-56.

Materials

- a. Maphtha solvent, conforming to ASTM D-91.
- b. Freon TF solvent, trichlorotrifluoroethane, E. I. du Pont de Nemours and Company.
 - c. Aluminum oxide polishing compound, 150 grit.
 - d. Seawater, ASTM D-665.
- e. PTFE tape, 1/2-inch-wide, Scotch Brand No. 48, Minnesota Mining and Manufacturing Company.
 - f. Typewriter brush, Federal Specification H-B-00681c.
- g. Temperature and pressure transfer oil MIL-L-17331, MS 2190-TEP.

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- A Air Driven Pump (rated 30,000 psig)
 B Pump Reservoir (capacity 3 gallons)
 C Pressure Generator (30,000 psig)
 11 cc)
 D Pressure Gage (25,000 psig)
 B Rupture Assembly Set (22,000 psig)
 F Fluid Separator (325 cc, 30,000 psig at 72° F)

 G Support Stand (30 x 36 x 40 inches)
 H Heated Oil Bath (20 gallons, 140° F, 2190-TEP)
 I Reaction Vessel (2000-ml, rated 30,000 psig at 125° F)
 J Thermocouple
- All tubing = 1/4-inch 00, 1/16- or 3/32-inch ID, rated 60,000 psig.
- All valves, tees, elbows rated 30,000 peig.
- All connections use superpressure fittings.

Auxiliary Equipment (Not Shown)

High-Speed Bath Stirrer Immersion Heaters (1500 watts maximum) Bath Temperature Control Recording Potentiometer Air Lines, Filters, Pressure Regulators, etc

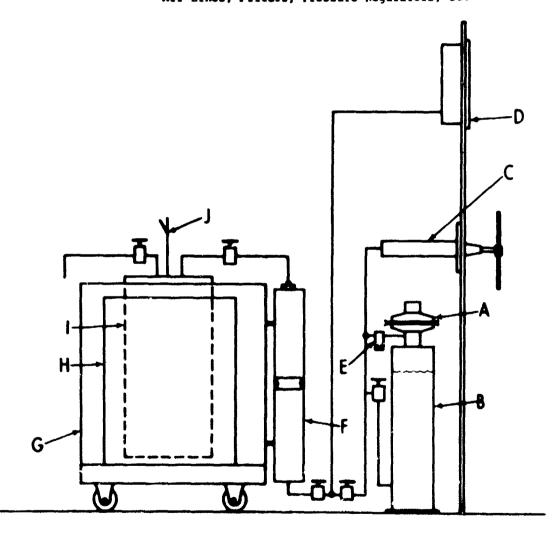


Figure 3 (C3) - 20,000 PSIG Static Test Unit

MAVAL SHIP RESEARCH AND DEVELOPMENT LABORATORY

STEEL, Stainless, Type 316

ALUMINUM 6061, Specification QQ-A-250-11

COPPER-WICKEL, 70-30, Specifications MIL-C-15726 or MIL-T-00/6420

STEEL, QQ-8-698, Grade 1009

ALUMINUM, QQ-A-250-4b

COPPER, QQ-C-576a

MICKEL-COPPER, QQ-N-281, Class A, Monel 400

BROWZE, MIL-B-16541A(WEP) (1/16 inch thick)

PHOSPHOR-BRONZE, QQ-B-750, Composition A

SILVER BASE BRAZING ALLOY, MIL-B-15395A, Grade IV

STEEL, Galvanized, Electrodeposited, QQ-Z-325A, Type II, Class I

Specifications for Items Above

Metal Specimens, 1 x 1 x 0.032 inch with a 1/4-inch hole in center, finish to conform to that given in Federal Test Method Standard No. 791a, Method 5308.4

Figure 4 (C3) Metal Specimens Used

Preparation of Sample Container and Specimen Holder
a. The PTFE bag, end pieces, and specimen holder shall be washed with ASTM D-91 naphtha, soap and water, distilled water, and oven-dried at 140° F.
Preparation of Specimens
a. Metallic specimens shall be cleaned, polished, and weighed as in "Ambient Pressure Stirred Corrosion Procedure," Method Cl.
b. Hommetallic specimens shall be prepared, cleaned, and volume measured as in ASTM Method D_471-66.
c. The specimens shall be attached to the specimen holder so as to provide space between specimens, and between the specimens and the wall of the test cell so that all parts of the specimen are flooded with the fluid. Where insulated metallic specimens are used, the order of assembly shall be as given in Method Cl. When metallic couples also are to be studied the order of assembly shall be as shown in the "20,000 Stirred Corrosion Procedure," Method C4, except that the insulated specimens shall be placed on the specimen holder above the coupled specimens.
Procedure
a. Bring reaction vessel and transfer oil to test temperature.
b. Assembly of test cell.

- (1) Fit PTFE bag into the bottom and top closures.
- (2) Insert the specimen assembly into the bag through removable part of the top closure placed on the bag.
- (3) Fill the cell with 825 ml of test fluid through the top port, taking care to purge out the air. Close the top port.
- (4) Determine the total weight of the test cell. This is done to determine if the cell leaks during test. The test cell weight is again measured after the test period.

- c. Place the test assembly in the reaction vessel in transfer oil.
- d. If sea-water contaminant is to be used, allow the test cell to remain in the reaction vessel for 1 hour. Then remove the test cell from the reaction vessel and add seawater through the top port. Close the top port and return the test cell to the reaction vessel.
- e. Close the reaction vessel, placing the thermocouple end at the top of the test cell.
- f. Add sufficient additional transfer oil to fill the reaction vessel and purge out the air and close the vessel.
- g. Bring the system to test pressure, Maintain constant pressure and temperature throughout the test.
- h. At the end of the test period remove the test cell from the reaction vessel and *eparate the specimens and the test fluid.
- i. Measure the properties of the test fluid to detect changes (viscosity, acid content, density, metal content, etc).
 - j. Measure changes in the specimens.
- (1) Clean, weigh, and photograph the specimens as in Method C2 ("20,000 PSIG Pressure-Cycled Compatibility Procedure").
- (2) Determine the volume, hardness, tensile strength, and elongation changes in the nonmetallic specimens as in ASTM D-471-66.

C4. 20,000 PSIG, Stirred Corrosion Procedure

Scope - This method is intended to measure the relative protection provided to metals and alloys used in deep submergence equipment upon contamination with seawater at high ambient pressures.

Outline of Method - A sample of test oil is brought to a predetermined temperature in a high-pressure reaction vessel. A
weighed metal specimen assembly is immersed in the oil, and the
stirrer blade and vessel cover are fitted onto the vessel.
After stirring for a 1-hour conditioning period, the desired
amount of sea-water contaminant is added to the oil. The desired
test pressure is applied to the vessel contents. The test temperature, pressure, and stirring are maintained for a predetermined reaction period (usually 30 days). The specimen assembly
is removed from the vessel. The specimens are cleaned, weighed,
and photographed.

Apparatus

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- a. Reaction vessel The reaction vessel shall have a 3 5/8-inch ID and a 13-inch useful height. It shall have a 2100-ml capacity and be made of, or completely lined with, a corrosion resistant alloy, such as Hastelloy C. The stirrer shall have a speed of 1000±50 rpm. The vessel cover shall have fluid inlet and outlet ports, thermocouple well, and blowout disk assembly.
- b. Specimen holder The specimen holder shall be of 304 stainless steel and of a configuration so that up to 50 specimens are hald between stirrer and wall. Figure 1 shows a typical holder and specimen array.
- c. Constant-temperature bath The constant-temperature bath shall contain MS 2190-TEP petroleum oil as a heating medium. It shall be designed to permit the immersion of the reaction vessel up to the lower rim of the locking nut. The bath shall be capable of maintaining the test oil at any temperature between 100°-250°±2° F.
- d. Pressure supply The pressure shall be supplied by a high-pressure pump, such as a 30,000 psig Sprague diaphragm pump, Model S-216-CPR-300. All tubing and fittings shall be high-pressure 304 or 316 stainless steel. The pump shall be capable of maintaining test oil at 0-20,000±25 psig. A diagram of the system is shown in Figure 2.

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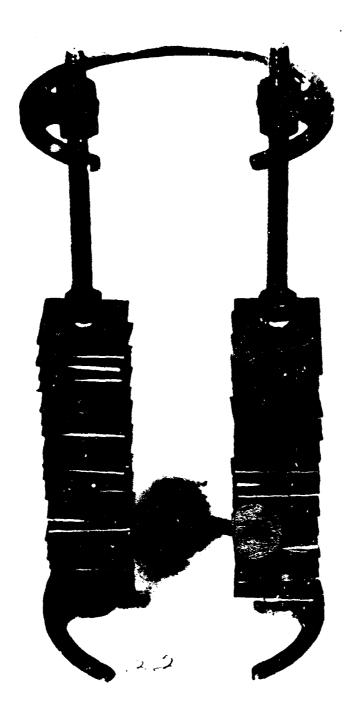


Figure 1 (C4)
Specimen Holder and Specimens

NAVAL SHIP RESEARCH AND DEVELOPMENT LABORATORY

H - Heated Oil Bath (20 gallons, 140° F, A - Air Driven Pump (rated 30,000 psig) B - Pump Reservoir (capacity 3 gallons) 2190 -TEP) 1 - Readtion Vessel (7100-ml, C - Pressure Generator (30,000 paig, .11 cc) rated 50,000 paig at 105° F) D - Pressure Gage (25,000 paig) E - Rupture Assembly Set (22,000 paig) J - Thermocouple K - Marine Propeller F - Fluid Separator (325 cc, 30,000 paig at L - Permanent Magnetic Drive G - Support Stand (30 x 36 x 40 inches) All tubing - 1/4-inch GD, 1/16, or 3/32-inch ID, rate4 60,000 pmig. All valves, tees, elbows - rated 30,000 paig. All connections use superpressure fittings. Auxiliary Equipment (Not Shown) High-Speed Bath Stirrer Immersion Heaters (1500 wates maximum) Bath Temperature Control Recording Potentiometer Air Lines, Filters, Pressure Regulators, etc. D-VARIABLE SPEED DRIVE 1/2HP LACTOR

Figure 2 (C4) - Stirred Reaction Versel for 20,000 PSIG

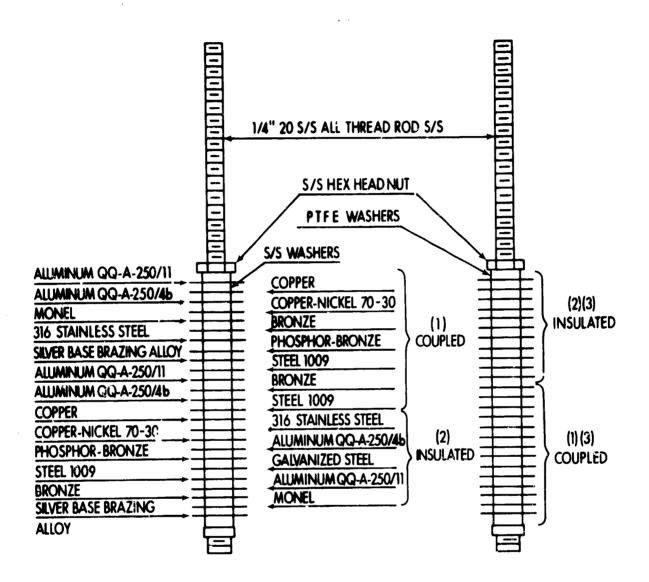
- e. <u>Recording potentiometer</u> A recording potentiometer capable of recording oil temperatures of 100°-250°±2° F shall be used.
- f. Corrosion specimens The corrosion specimens shall be 1 x 1 x 0.052 inch with a 1/4-inch hole in the center. The specimen shall have a finish (before polishing) conforming to Pederal Test Method Standard No. 791a, Method 5308.4. The specimens shall be of any deep submergence alloy or metal to be studied. Those used by NAVSHIPRAMDLAB Annapolis are shown below.
 - (1) STEEL, Stainless, Type 316.
 - (2) ALUMINUM 6061, Specification QQ-A-250-11
 - (3) COPPER-NICKEL, 70-30, MIL-C-15726 or MIL-T-00/6420.

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- (4) STEEL, QQ-S-698, Grade 1009.
- (5) ALUMINUM, QQ-A-250-4b.
- (6) COPPER, QQ-C-576a.
- (7) NICKEL-COPPER, QQ-N-281, Class A, Monel 400.
- (8) BRONZE, MIL-B-16541A(WEP) (1/16-inch-thick).
- (9) PHOSPHOR-BRONZE, QQ-B-750, Composition.
- (10) SILVER BASE BRAZING ALLOY, MIL-B-15395A, Grade IV.
- (11) STEEL, Galvanized, Electrodeposited, QQ-Z-325A, Type II, Class I.

A typical order of assembly of electrically coupled and insulated specimens is shown in Figure 3.

g. Spacers - Spacers for specimens shall be made of 304 stainless steel and of PTFE. They shall be cut from 1/4-inch ID, 3/8-inch OD tubing and shall be 1/8-inch-thick.



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- (1) 304 STAINLESS STEEL WASHERS USED FOR COUPLING COUPONS
- (2) POLYTETRAFLUOROETHYLENE WASHERS USED FOR INSULATION
- (3) SPECIMENS IN SAME ORDER AS OTHER ROD

Figure 3 (C4) - Specimen Assembly for Stirred Corrosion Test

Materials

- a. Naphtha solvent conforming to ASTM D-91.
- b. Freon TF solvent trichlorotrifluoroethane, E. I. du Pont de Nemours and Company.
 - c. Aluminum oxide polishing compound, 150 grit.
 - d. Seawater ASTM D-665.
- e. PTFE tape, 1/2-inch-wide, Scotch Brand No. 48, Minnesota Mining and Manufacturing Company.
 - f. Typewriter brush, Federal Specification H-B-00681C.

Preparation of Apparatus

- a. Piping and connections shall be drained free of oil.
- b. The internal surfaces of the reaction vessel shall be wiped clean with lint free rags.
- c. The vessel shall be filled with test oil and stirred for 1 hour, then drained free of oil.
 - d. Repeat a., b., and c. two additional times.
 - e. Drain and fill with test oil.

Preparation of Corrosion Specimens

- a. Handle specimens with disposable polyethylene gloves.
- b. Flush with naphtha to remove preservatives.
- cotton wads (do not polish plated specimens).
 - d. Make polishing strokes in one direction.
- e. Turn specimen 90° and polish until previous polishing marks are removed.

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- f. Brush with camel hair brush.
- g. Use wash bottle to flush specimen with jet of naphtha, then a jet of Freon TF.

- h. Air dry and place in desiccator.
- i. Weigh on semimicrobalance, record weight to 0.00001 gram.

Preparation of Specimen Holder and Spacers - Specimen holder and spacers shall be cleaned with naphtha, soap and water, distilled water and then oven-dried at 140° F.

Procedure

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- a. Assembly of specimens Handle the specimens and specimen rack with polyethylene gloves. Wrap the 1/4-inch specimen rack and rods with PTFE tape to insulate from the specimens. Place the specimens on rods in desired order. Use two PTFE spacers to prevent electrolytic contact between the specimens, or use two stainless steel spacers to form electrolytic couples between the specimens. Order of assembly is shown in Figure 3.
- b. Add the test oil to the reaction vessel. (The reaction vessel remains in constant temperature bath at all times.) After the test oil is at desired temperature, soak the specimen assembly in the reaction vessel for 1 hour and securely close the reaction vessel.
- c. Attach the specimen assembly to the cover. Add the desired amount of seawater. Lower the cover into the vessel.
- d. Bleed off the air from the reaction vessel by pumping in excess oil.
- e. Close the valves, pressurize the system, and start the stirrer.
- f. The stirrer may be operated continuously or intermittently, as desired.
- g. At the end of the test period the pressure is released and the specimen assembly is removed. The specimens are stored in naphtha prior to cleaning.
- h. The specimens are cleaned by successive flushes with naphtha and brushing with a naphtha-wet typewriter brush.

- i. A final flush with Freon TF is made, then the specimens are placed in a desiccator and weighed to obtain the gain or loss due to corrosion.
- j. Record of changes in the weight and the appearance of specimen is made by written notes and photographs.

C5. On-Off Rust Test Procedure

Score - This method is intended to establish the ability of a finis to prevent corrosion when contaminated with seawater under conditions of intermittent agitation.

Outline of Method and Apparatus - The ASTM D-665 method and apperatus is used except as described below. An ASTM D-665, double-blade stirrer, paragraph 9b, is used. The specimen is polished and attached to the holder using a 1/16-inch-thick, 1/2-inch-diameter PTFE gasket between specimen shoulder and holder. After the 30-minute soaking period, 150 ml of the 300-ml fluid sample is removed and 150 ml of seawater is added. The security is added dropwise from a burette while stirring. The burette top is just above the surface of the fluid. The semmater shall be added within 30 minutes. The oil and water sample is stirred for 15 minutes, once every 24 hours. After the first 24 hours the specimen is observed for rusting and the fluid-water emulsion examined for stability; it is then examined twice weekly during the test period. Distilled water is added at these times to make up for water lost by evaporation. The test period is 30 days. Quadruplicate determinations will be made. A fluid is considered to have satisfactory rust protection if three out of four specimens show no rust and no more than light rust is observed on the fourth specimen after 30 days.

ELECTRICAL PROPERTY MEASUREMENT PROCEDURES

Methods of determining dielectric properties of fluids at temperatures as low as 28° F and pressures up to 20,000 psig, particularly as they are affected by seawater and carbon contamination, have not been fully developed. The following test methods, El through E7, are performed at room temperature and atmospheric pressure and are expected to give a good first approximation of the properties being measured. As these methods are improved and high pressure methods are developed they will be added.

El. Resistivity

Scope - This method is intended to measure the insulating characteristics of a fluid. It determines the value of resistivity of a fluid.

Outline of Method and Apparatus - ASTM Method D1169 is used except as noted below. The fluid sample is placed in a test cell and resistivity measured with a General Radio Type 1644A megohm bridge or equivalent. The test cell may be any one of three cells described in Figure 2, 3, or 4 of the appendix to ASTM D1169 (Specific Resistance of Electrical Insulating Liquids). The temperature of the fluid is held between 65°-85° F and preferably 77±2° F. Resistivity is recorded as ohm-cm at °F. A tentative standard of acceptable resistivity for dielectric fluids has been set at 3.0 x 1011 ohm-cm, minimum.

E2. Dissipation Factor

Scope - This method is intended as a measure which will be useful in predicting decreases in the efficiency of fluid immersed electrical equipment due to electrical energy losses through a fluid in an electric field in a nonsinusoidal a-c system. Specifically, the method measures the loss angle of a fluid filled cell on a capacitance bridge.

Outline of Method and Apparatus - The fluid sample is placed in a test cell of the type referred to under Test Method El, "Resistivity". Dissipation factor is measured with a General Radio Type 1615 or 1617 capacitance bridge or the equivalent of either or these. The temperature of the fluid is held between 65°-85° F and preferably 77±2° F. Dissipation factor is recorded as percent at °F. A tentative standard of acceptable dissipation factor for dielectric fluids has been set at 5.0%, maximum.

B3. Dielectric Breakdown Voltage

1

1 1

Scope - This method is intended to measure the ability of a fluid to withstand electrical stress. It determines the voltage at which breakdown occurs between two electrodes under prescribed conditions.

Outline of Method and Apparatus - ASTM D877 is used, with the following exceptions:

- a. The electrode spacing is 0.050±0.001 inch.
- b. Voltage rise rate is 600 volts per second ±20%.
- c. Five separate readings are taken on the same sample, with a 3-minute wait between readings. The result is reported as the average of the five readings, in kilovolts.
- d. The temperature of the fluid sample should be between 65°-85° F and preferably 77±2° F. The temperature of the fluid is recorded. A convenient single package instrument for this test is a Model 4507 "Oil Testing Hypot" manufactured by Associated Research, Incorporated, Chicago, Illinois. A tentative standard of acceptable dielectric breakdown voltage for dielectric fluids has been set at 15.0 kv, minimum, at a 0.05-inch electrode gap.

E4. Stability of Seawater - Fluid Emulsions

Scope - This method describes a procedure for determining the stability of water dispersed in a pressure-compensating fluid in order to estimate fluid utility for electrical equipment service.

Outline of Method - Oil (100 ml) and synthetic seawater (10 ml) are stirred for 15 minutes and transferred to a 100-ml graduated cylinder. The time required for separation of synthetic seawater from the compensating fluid is recorded.

Apparatus

- a. Beaker, 250 ml.
- b. Mechanical stirrer as described in ASTM $D1\frac{1}{2}79$ or equivalent.
 - c. Buret, 25 ml.
 - d. Cylinder, graduated, 100 ml in 1-ml increments.
 - e. Volt-ohmmeter capable of measuring 1 megohm and less.

Procedure

- a. Measure 100 ml of the test fluid into a 250-ml beaker.
- b. Add 10 ml of synthetic seawater (SSW), prepared according to ASTM D665 (IP 135), dropwise, with stirring.
- c. Stir the mixture vigorously with a mechanical stirrer, for 15 minutes.
- d. Stop the mixing and transfer the mixture immediately to a 100-ml graduated (glass) cylinder. This latter step should require about 10-20 seconds. (At this point the mixture may have completely separated into two layers, or it may be a milky emulsion.)
- e. The time require for separation of a small quantity (1/2 ml or less) of SSW is now measured as follows: Two bare 1/16-inch-diameter copper wires, connected to a volt-ohmmeter, are inserted into the graduated cylinder, touching the bottom of the cylinder. The wires are kept 1/4 to 1/2 inch apart. Separation of SSW is indicated when resistance across the wires drop to less than 0.1 megohm.

f. Stability of the emulsion is recorded as the time required for the separation of synthetic seawater, as described in e. The fluid is classified according to time required for separation. A tentative standard is as follows:

	Classification	Time Required for Water Separation				
A.	Suitable for use with motors	5 minutes or more				
В.	Questionable for use with motors	1-5 minutes				
с.	Unspitable for use with motors	<l li="" minute<=""></l>				
D.	Suitable for contactors, switches, etc	No emulsion stability requirement				

E5. Changes in Dielectric Properties Resulting from Sea-Water Contamination

Scope - This method describes the preparation or samples to determine the effect of sea-water contamination on the electrical properties of fluids as determined by Methods E1, E2, and E3.

outline of Method - The methods described in MI, M2, and M2 as used to measure the changes in dielectric properties brought as by contamination with SSW. The effects of three concentrations, 0.1%, 0.5%, and 2.0%, are measured.

Procedure

- a. 0.1% SSW To 400 ml of the test fluid, 0.4 ml of SSW is added dropwise, with stirring. The mixture is stirred vigor-ously with a mechanical stirrer (ASTM D1479) for 15 minutes, then it is allowed to stand for 5 minutes. The required sample is carefully poured (to avoid pouring out any settled water) into the appropriate test cell. Resistivity and dissipation factor are measured per Test Methods El and E2. The sample is then recombined with the remaining portion and the mixture is stirred vigorously for 5 minutes more. A 100-ml sample is removed, and dielectric breakdown voltage is measured per Test Procedure E3. The 100-ml sample is then discarded.
- b. 0.5% SSW The procedure of a. is repeated, except add 1.2 ml of SSW to the 300 ml of liquid remaining from a.
- c. 2.0% SSW The procedure of a. is repeated, except add 3.0 ml of SSW to the 200 ml of liquid remaining from a.

Results are reported as resistivity, dissipation factor, and dielectric breakdown voltage at the three levels of SSW contamination.

E6. Changes in Dielectric Properties Resulting from Carbon Contamination

Scope - This method describes the preparation of samples to determine the effect of fluid contamination by finely divided carbon on the electrical properties as determined by Methods El, E2, and E3.

Outline of Method - The methods described in El, E2, and E3 are used to measure the changes in dielectric properties brought about by contamination by finely divided carbon which simulates brush wear or fluid degradation. The effects of three concentrations, 0.1%, 0.25%, and 0.50%, are measured.

Procedure

- a. 0.1% carbon To 250 ml of test fluid is added 0.025 gram of "Eagle" brand lamp black, manufactured by Columbian Carbon Company, New York, New York, while stirring (ASTM D1479 stir er). After all the lampblack has been wetted by the fluid, stirring is continued vigorously for 15 minutes. Resistivity, dissipation factor, and dielectric breakdown voltage are measured on the test mixture. The sample used for the dielectric measurements (approximately 100 ml) is recombined with the remaining material prior to Step b.
- b. 0.25% carbon To the 250-ml mixture of Step a., 0.0375-gram additional lampblack is added, with stirring, and stirring is continued for 15 minutes. The procedure of Step a. is then repeated.
- c. 0.50% carbon Additional lampblack (0.0625-gram) is added and Step b. repeated.

Results are reported as resistivity, dissipation factor, and dielectric breakdown voltage at the three levels of carbon contamination.

E7. Effects of Electrical Arcing on Fluids

Scope - Th's method determines the ability of a fluid to withstand the effects of electric arc discharge.

Outline of Method - The fluid is subjected to a series of arcs at a specified rate, and the electrical properties are measured by Methods El, E2, and E3 to determine fluid property changes.

Apparatus - In addition to the apparatus required for Methods El-E3, the following are required:

- a. Guardian Manufacturing Company Type 2110V double-pole/single-throw, normally open (D.P.S.T., N.O.) relay with silver cadmium contacts.
- b. Millipore membrane filter, diameter 47-mm pore size 0.8-micrometer or equivalent, as described in S/E Aerospace Recommended Practice, ARP 785.
- c. Power supply, 90-volt open circuit, 10-ampere closed circuit.
 - d. Counter capable of recording 50,000 operations.

Procedure

- a. The testing is carried out with a Guardian Manufacturing Company Type 2110V D.P.S.T., N.O. relay having silver-cadmium contacts. The outer covering of the coil and the adhesive material are first removed and the coil recoated with RTV silicone rubber, to minimize interaction with the test fluid.
- b. The cleaned relay is immersed in 400 ml of the test fluid at the desired test temperature. The fluid is subjected to 50,000 arcs (1 arc = 1 make + 1 break of the contacts) under a primarily resistive load with an open-circuit voltage of 90 volts and a closed-circuit current of 10 amperes. The rate of arcing is 5 to 10 arcs per minute. If the contacts fail, as indicated by arcing when closed, before 50,000 operations, they must be replaced.
 - c. The following are measured and reported as indicated:
- (1) Resistivity, dissipation factor, and dielectric breakdown voltage (see Test Methods El-E3) initially and after 50,000 arcs.

- (2) The amount of solid products generated is measured gravimetrically by the method described in SAE Aerospace Recommended Practice, ARP 785. The weight is reported in milligrams in total sample.
- (3) The measurements of (1) are repeated on the filtered fluid.

NOTE: This test is to be revised when more experience is gained at higher current values.

E8. Life of contacts in the Fluid under Pressure

Scope - This method determines the effect of fluid immersion on relay contacts subjected to high pressure.

Outline of Method - A relay is operated immersed in fluid under 6000 psi pressure to the point of failure of the electrical contacts.

Apparatus - In addition to the apparatus required for Method E/, the following will be required:

- a. Cylindrical PTFE or polyethylene container capable of containing relay immersed in fluid.
- b. Pressure vessel to pressurize fluid and relay to 6000 psi with electrical connections for relay operation under pressure.
 - c. Counter to record number of cycles to failure.
- d. Power supply capable of 50 volts open circuit,
 10 amperes closed circuit.

Procedure

- a. The test device used is the same as that described under Method E7, a. The relay is mounted inside a test cell having a cylindrical thin PTFE or polyethylene wall. The volume of fluid used is not critical.
- b. The test cell is pressurized to 6000 psi. Arcing is then carried out a rate of five to ten operations (makes and breaks) per minute, to the failure point. A primarily resistive load is used, with an open-circuit voltage of 50 volts and a closed-circuit current of 10 amperes. Failure normally occurs by a buildup of solid products between contact surfaces, preventing circuit interruption when contacts are in the open position.
- c. Since contact life varies randomly over a wide range a minimum of ten tests is desirable and the spread as well as the average value are to be reported.

NOTE: This test is to be revised when more experience is gained at higher currents and higher pressures.

CHAPTER 111

FLUID AND LUBRICANT PROPERTY VALUES, APPLICATIONS AND LIMITATIONS

This chapter provides available physical and chemical properties of fluids, suggested applications, and possible limitations of fluids for deep submergence vehicles. Where known, the estimated fluid cost is given. The tables have been prepared to provide for the addition of properties, when available, and of other fluids as they become known and applications warrant.

The possible limitations are given as a warning so that particular attention will be focused on any fluid property weakness. These limitations are based on general use of the fluid for all types of applications in a deep ocean environment.

Careful design and selection of system components may permit the use of a fluid or lubricant which would be unacceptable by the usual standards. This handbook does not consider the exceptions, but rather states the limitations as a warning. If a designer is compelled by circumstances to create an exception, these warnings should show where the design effort must be directed.

Tentative guidelines for suggested fluid uses and possible fluid limitations have been developed. They are based on the combination of application requirements, equipment developments, laboratory measurements of fluid properties, and field experience.

In systems with moving parts, the fluid depth capability is that at which pressure or temperature effects cause the viscosity to exceed 100 centistokes.

Fluid lubricating-ability criteria are based on: (1) weartest and rolling-contact/fatigue-test performance, (2) known viscometric characteristics, and (3) known performance in operating equipment.

Corrosion protection is based on laboratory and field evidence of inertness of system ferrous and nonferrous metals, with and without sea-water contamination.

The limiting density for fluids in deep submergence vehicle applications where weight is critical is considered to be 1.0 gram per cubic centimeter.

The criteria for the fire resistance of fluids are based on the autoignition temperature of their vapors and combustion characteristics at high pressures. Fluids having ambient pressure flash points under 300° F are considered flammable.

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Electrical application guidance for fluids is based on their tentative laboratory dielectric test limits given in Chapter II, on their ability to cope with intrinsic (carbon) and extrinsic (sea-water) contamination, and on their sea-water fluid emulsion stability. Critical fluid properties for each of the following uses are:

- Electric motors: initial dielectric properties, reaction to arcing (for d-c motors), heat transfer properties, emulsion stability, and compatibility with other materials.
- Switches, contactors, and circuit breakers: initial dielectric properties, heat transfer properties, reaction to arcing, and compatibility with other material.
- Stationary electrical components: initial dielectric properties, heat transfer properties, and compatibility with other materials.

Fluids for power transmission, such as hydraulic systems, must have satisfactory performance in all fluid and lubricant property categories, including dielectric properties. Fluids for mechanical elements, such as gear trains and hydraulic motors, must exhibit good lubricating properties and good corrosion inhibition while dielectric properties are less critical. Fluids for environmental protection of moving electrical components must have favorable dielectric properties, afford good corrosion inhibition, and have favorable lubricating properties with and in the absence of sea-water contamination. Fluids for environmental protection of nonmoving electrical components in sealed cases must have favorable dielectric and corrosion inhibiting properties, but here the lubricating properties are less critical.

Representative federal specification products and representative military specification products are tabulated in numerical order. Proprietary products are coded and are listed in the order in which they were received for evaluation.

The fluids are listed in Table 1 (see page III-4) for ready reference in the order as noted above, along with common designation, base fluid composition, and a listing of possible

uses with a general assessment of applicability to possible uses. The assessment of the fluid utility is based on its use for deep ocean applications. Even though a fluid may have been used successfully for aircraft, missile, or surface ship requirements, its satisfactory performance under deep ocean conditions is not assured. The symbols on the summary table are defined as follows:

- P indicates that the fluid may be used in the listed application with normal design precautions and considerations.
- Q indicates that the fluid has properties which make its use in the listed application questionable. It does not mean that the fluid cannot be used in the listed application. It does mean that if the fluid is used in such an application, special precautions and special design considerations must be observed. A fluid in this category may possibly be suited for short-term use only.
- \bullet K indicates that the fluid has either been used or has been tried in the listed application.
- Blank (-) indicates that there is insufficient available information to make any assessment of the utility of the fluid in the listed application.

In the case of a combined symbol, such as KP or KQ, the K indicates that the fluid has been tried for the use indicated, and the P or Q indicates that it is either possible or questionable, as defined above.

The listing of P after a product does not constitute endorsement for use, and the listing of Q does not constitute condemnation.

Table 1 Summary List of Fluids and Lubricants Tabulated

Specification or Trade Name				Application				
					1			Nonmoving
Proposed Proposed	Completion or	Other						1
Pederal Specification Products Petroleum Petrole								
VV-1-590a	. Terror Million		L	<u></u>	A	<u> ston</u>	Inuneration	1 Indic I as Off
WD00107810 cs		Federal Spe	ecification	Produc	t s			
Military Specification Products							4	
Mill-H-3606B			Silicone	Q	U	KQ	KQ	YP YP
NIL-H-5666B	VV-D-001078(50 cs)	Damping Fluid	Silicone	KΩ	Q.	Ų	Ù	<u>(</u>
Third JP-5		Military Spe	cification	Produc	ts			
MIL-L-6081C			Petroleum	KP	KP	KР	P	P
MIL-H-6085C	ML-J-5624F	JP-5	Petroleum		ΚŲ	KÇ	Q	Q
MIL-II-6085C Aircraft Hydraulic Petroleum K K0 K0 K0 K0 MIL-II-6085A Aircraft Instrument Oil Synthetic K0 K0 K0 O O O O O O O O O	MIL-L-6081C,	Jet Engine Lubricating	Petroleum	KQ	IKU)	KQ	KQ	0
System Preservative	Grade 1010	Oil		1	-		ļ	!
MIL-I-6085A Aircraft Instrument Oil Synthetic KQ KQ KQ Q Q Q Q Q Q	MIL-II-6083C	Aiscraft Hydraulic	Petroleum	К	. KQ	ΚQ	KQ	KO
MIL-L-7808G Gas Turbine Lubricating Synthetic -		System Preservative		1	-			1
MIL-L-7808G Gas Turbine Lubricating Synthetic - MQ Q Q Q Q Q MIL-C-5188C Gas Turbine Engine Synthetic KO KO Q Q Q Q Q Q Q Q Q		Aircraft Instrument Oil	Synthetic	KQ	KQ	KQ	Q	0
MIL-C-7070A	MI'L-7808G		Synthetic	-	KQ	Q	Q	0
MIL-C-J-188C Gas Turbine Engine Synthetic KQ KQ Q Q Q Q Q Preservative Petroleum Q P P P P P P P	0300	 		 			 	ļ
Preservative	MIL-L-787UA	<u> </u>						
MIL-F-17111	MIL-C-2,150C	-	Synthetic	I KO	ΚQ	Q	, Q	0
Fluid Flui	MIL-F-17111	13	Petroleum	e e	P			P
MIL-L-17672, Turbine Oil and Hydrau- Petroleum KQ KQ Q Q P				`	•			
NS 2110-TH	MIII17672.		Petroleum	KO	KO	0	0	P
MIL-S-21508A Damping Fluid Silicone Q Q KQ KP KP KP MIL-L-23699A Aircraft Turboprop and Synthetic KQ - - - -		-				_	_	
MIL-L-23699A			Silicone	0	0	KO	KP	KP
Turboshaft Lubricant Aircraft High Temperature Hydraulic Fluid Fluid Petroleum Aircraft High Temperature Hydraulic Fluid Petroleum Aircraft High Temperature Hydraulic Fluid Petroleum Aircraft and Missile Aircraft and Missile Petroleum Aircraft and Missile Aircraft and								
MIL-H-27501A			0,	Ī	""		i .	1
ture Hydraulic Fluid	MTIH_27501A		Petroleum	 	 -	 -		
MIL-H-45004 Missile Hydraulic Fluid Petroleum KQ	MB-H-E COLA		re crore am	! -	-	-	_	
NIL-H-51019B	M11 H 45004		Petroloum		 		 	
Hydraulic Fluid Proprietary Fluids Fluid Code A Sea-water Erulsifying Petroleum KQ KQ Q Q Q Fluid Code B Petroleum KP KQ Q Q Q Q Q Q Q Q							 	
Fluid Code A Sea-water Emulsifying Petroleum KQ KQ Q Q Q Pluid Code B Proposed Specification Petroleum KP KQ Q Q Q Q Q Q Q Q								<u> </u>
Fluid Code B		Frop	rietary Flu	uids				
Fluid Code B								
Fluid Code B	Fluid Code A		Petroleum	i KQ	KQ	Q	Q	5
Fluid Code C		Fluid, Type I			ļ		<u> </u>	
MIL-H-25593 Missile Hydraulic Fluid Petroleum		-						
ItyCraulic Fluid	Fluid Code C		Petroleum	KP	KQ	Q	Q	Ĉ
Fluid Code D Traction Drive Fluid Petroleum -			 	ļ			1	
Fluid Code E - Petroleum - KQ KQ - P Fluid Code F - Petroleum P P - - P Fluid Code G - Petroleum P P - - P Fluid Code H - Petroleum P P -	Fluid Code D	<u> </u>	Petroleum		-			
Fluid Code G		•		-	KQ	KQ	-	P
Fluid Code G	Fluid Code F	<u> </u>	Petroleum	P	Ь		 	P
Fluid Code H - Petroleum P P -							-	
Fluid Code J USP Mineral Oil Petroleum - Q KQ KQ KP Fluid Code K NF Mineral Oil Petroleum - Q - - - Fluid Code L Lubricity Improved Silicone Silicone Q KQ KP KP Fluid Code M - Petroleum - P Q Q Q Fluid Code N Sea-water Compatible Water - Q Q Q Q								
Fluid Code K NF Mineral Oil Petroleum - Q - - - Fluid Code L Lubricity Improved Silicone Silicone Q KQ KP KP Fluid Code M - Petroleum - P Q Q Q Q Fluid Code N Sea-water Compatible Water - Q Q Q Q Q Q							KO	KP
Fluid Code L Lubricity Improved Silicone Silicone Q KQ KP KP Fluid Code M - Petroleum - P Q Q Q Q Fluid Code N Sea-water Compatible Water - Q Q Q Q								
Fluid Code M - Petroleum - P Q Q Q Q Fluid Code N Sea-water Compatible Water - Q Q Q Q Q		Lubricity Improved						KP
Fluid Code N Sea-water Compatible Water - Q Q Q Q		Silicone						
	Fluid Code M			-				Q
water Giycoi	Fluid Code N	Sea-water Compatible Water Glycol	Water	-	Q	Q	Q	Q

P - Possible use

k - Known or attempted use

Q - Questionable for use in this application - (blank) - Insufficient information available for

FEDERAL SPECIFICATION PRODUCTS

VV-I-530a

Suggested Uses and Possible Limitations

The oil covered by Federal Specification VV-I-530a is a petroleum-based fluid intended to serve as an insulating and cooling medium for transformers, oil switches, and circuit breakers at atmospheric pressure. The VV-I-530a fluid also can be used as an immersion medium for equipment to a depth capability of 8000 feet. The fluid lacks adequate inhibition to prevent sea-water corrosion of ferrous and nonferrous system components. Its relative lubricating ability has not yet been established. Its poor sea-water emulsion stability makes it unacceptable for use in electric motors. Good dielectric properties and intermediate viscosity make it a moderately good choice for all other electrical applications.

Properties of VV-1-950a(1) (Petroleum Base Fluid)

Colored driver to investment and their development with the second secon	- 	,	· · · · · · · · · · · · · · · · · · ·		g mesmeg syraeps or s
Viscometric Properties					No theat
Viscosity, contistokes, at:	51.0 p	100° F	150° F		1
0 pstq			 		
\$,000 ps 14	57.00	9,65	4.36		See KSimi.
5,000 parq	99.99	16.78	6.44		Annogarlis segar
8,000 parq	154.9	20.47	3.03		MATIAN SE
10,000 parq	259.9	30.57	11.54		188/118/10 (5/5)
15,000 parq	570.1	59.21	15.35		ļ -
19,000 bard	912.0	76.67	21.62		1
refere battl	1016	141.5	36.21		-
					•
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·					1
					İ
					1
	.			_	
Viscosity, centistokes, at 210° 1	`• <u> </u>		!	<u>-</u>	ASTE D-44
0 psig	3		į		1
Viscosity Slope, ASTM	0.328				. .
ubrigating Ability]	
4 : ill Wear Test, 30 min, 50° C,					Ped. Method ***
100 steel, average scar dia.,	1				[(modified)
mm:					1
1 kg	· f				1 -
3 kg					1 -
5 kg					-
Rolling Contact Fatigue Test	i i		ļ		M11-H-19457
Life to 10% Failure					1
Life to 50% Failure	1				l
2110 00 70,0 1 011010					i
	}				1
					1
orrosion Protection					
	Fail				ASTM D-665
Stirred Rust Test, 10% seawater,	rall				ASTA DECOM
140° F, 2 days	 ,				Con Chank
On-Off Rust Test, 50% seawater,	Fail		•		See Chapter 1
140° F, 30 days					Test C-9
Ambient Pressure, coupon	1		}		See Chapter 1
stirred, corrosion test, weight				•	Test C-1
change, mg				•	
Copper	-54.5				1 -
Stainless Steel, 316	+3.2				-
Copper-Nickel (70-30)			i i		
	+2.1				j =
Aluminum, QQ-A-250-4b	+2.1				
					-
Aluminum, QQ-A-250-4b	-124.2 -61.3				-
Aluminum, QQ-A-250-4b Phcsphor-Bronze Steel, galvanized	-124.2 -61.3 -46.9				-
Aluminum, QQ-A-250-4b Phcsphor-Bronze Steel, galvanized Steel, 1009	-124.2 -61.3 -46.9				-
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11	-124.2 -61.3 -46.9 -547.5 +4.3(2)				-
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze	-124.2 -61.3 -46.9 -547.5 +4.3(2) -11.8				-
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				-
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy	-124.2 -61.3 -46.9 -547.5 +4.3(2) -11.8				See Charter
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				See Chapter :
Aluminum, QQ-A-250-4b Phcsphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Nonel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater),	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				See Chapter :
Aluminum, QQ-A-250-4b Phcsphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Nonel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				1
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens:	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				1
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				1
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, my Insulated Specimens: Copper Stainless Steel, 316	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				1
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, my Insulated Specimens: Copper Stainless Steel, 316 Copper-Nickel (70-30)	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				1
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				1
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				1
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				1
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				1
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				1
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, my Insulated Specimens: Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				1
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11	-124.2 -61.3 -46.9 -547.5 -4.3(2) -11.8 +3.1				1

	Y		· · · · · · · · · · · · · · · · · · ·	T	T THE MANNEY
Carragian Dr. (mat ion (Cont)		1		1	Method
Corrosion Protection (Cont)	ļ	1	j	1	ļ.
Flectically Coupled Specimens:		1			-
Copper-Aluminum, QQ-A-250-11	ŀ	ļ	1		-
Aluminum <u>vQ-A-050-4b</u> -	1	1			-
Copper-Nickel (70-50)	1	ļ	1	1	,
Monel-Bronze	J	}	1	1] -
Stainless Steel (516) -	Į.	Ī			ļ -
Phosphor-Bronze	ļ	1			1
Silver Base Brazing Alloy -	ļ] -
Steel, 1004			Į		!
Aluminum QQ-A-250-11 -		1		}] -
Bronze				İ	ļ
Aluminum QQ-A-250-4b -	[!	j	1	[_ [
Steel, 1009	1	1	1	1	
20,000 PSIG Stirred Corrosion		(Í	(See Chapter 2
Test, weight change, mg		1		1	Test C-4
Insulated Specimens:	1	İ	1		Test C=4
Copper		1	•	ł	į i
Stainless Steel, 516		1	1	ļ.	i - :
Copper-Nickel (70-30)	İ	1	1	i	{
Aluminum, QQ-A-250-4b	ļ	1	}) -
1	1	1	1		-
Phosphor-Bronze	ł	ł	}	1	- 1
Steel, galvanized	}	}	1	1	-
Steel, 1009					-
Aluminum, QQ-A-250-11	1	1	ļ	1	-
Bronze	1		1	ļ	-
Monel	ļ	l	}		1 -
Silver Base Brazing Alloy	j]	ļ]	, -
Electrically Coupled Specimens:		1		i	
Copper-Aluminum, QQ-A-250-11]	j	}	}	-
Aluminum, QQ-A-250-4b -			1		-
Copper-Nickel (70-30)	1				İ
Monel-Bronze	j	j		j .	_
Stainless Steel (316) -	ļ]			~
Phosphor-Bronze		ĺ	ľ	İ	(
silver Base Brazing Alloy -					_
Steel, 1009	1				[
Aluminum, QQ-A-250-11 -	l	ľ	ł		_
Bronze	l	1			
Aluminum, QQ-A-250-4b -	1		ľ		_
Steel, 1009			l	į	-
· -	i		1		Dynama and military
Pump Test	}	1	ļ	}	Proposed military
Average Weight Loss, mg	}	1	1	1	specification for
Steel Gears	{	i	1	1	sea-water emulsi-
Bronze Bushings	1	1	ļ		fying oils
Corrosion Coupons, weight loss,	ŀ	1	Ì		ļ
each, mg/cm ²	ŀ	1	Į.		
Copper	ļ	j)	J	-
Aluminum	Į	l			-
Steel, galvanized	j	J	ļ		-
Steel, 1009]	1		-
Silver Base Brazing Alloy		J]		-
Dielectric Properties		ļ	ļ]	ASTM D-1169 (mod-
Resistivity, 78° F, ohm-cm:			[ified). See Chap-
As-Received	5.2x10 ¹³	1			ter 2, Test E-1
With Sea-Water		1	į į		See Chapter 2
Contamination: (3)	15.0×1013	i	(İ	Test E-5
0.5% by volume			!	!	
2.0% by volume		1	!		_ /
With Carbon Contamination:		l		ı	Sec Chapter 2
0.1% wt/vol.					Test E-6
0.25% wt/vol.		ľ			TESC C-O
0.5% wt/vol.					: <u> </u>
				L }	

	1	T 800
parts the bearing went)		
After 10,000 Electric Arm		hee Chapter 1
(rate and breaks) at 40		Tes t 1 a7
volts, 'C arpetes, resiss		
time load Not filtered	3.4x1015	
Filtered	14.0x1014	<u> </u>
Solido peresated, gram	3.5	
Dissipation Factor, 73° F.		Leave Charles
As-Received	2.0	Test 1-2
With Sca-Water	,	See Chapter ;
Contamination: (3)	2.5	Test E=5
C. by volume		-
2.0% by volume		-
With Carbon Contamination:		See Chapter :
0.10° wt, vol.		Test E-6
O wt. vol.		
C. O. Wtyvol.	}	-
Attor : 0,000 Electric Arcs (makes and breaks) at 90		
volts, 10 amperes, resis-		1
tive load		
Not filtered	1.0	
Filtered	0.6	_
Solids generated, gram		<u> </u>
Diclectric Breakdown Voltage,		ASTM D-877 (mod-
0.0%-inch gap, 73° F, kv]]]	ified). See Chap-
As=Received	25.0	ter 2. Test E-3
With Sea-Water (3)		See Chapter ?
Contamination:(3)	8.9	Test E-5
2.0% by volume		-
With carbon contamination:	1 1 1	See Chapter 2
0.10° wt/vol.		Test E-6
0.25% wt/vol.		1 - 1030 11-0
0.50% wt/vol.	1 1	1 - 1
Arter 50,000 electric arcs		j
(makes and breaks) at 90		
volts, 10 amperes, resis-	1 1	
tive load		
Not filtered	10.1	-
Filtered	22.4	-
Solids generated, gram Contact Life, silver-cadmium, 50		See Chanter 9
volts, 10 amperes, resistive		See Chapter 2
load, 6000 psi, 65°-85° F		Test E-8
Number of tests	4	_
Operations to failure (range)	4-300	
Emulsion Stability		
Paddle Test, after 1-hour set-]	ASTM D-1401
tling:		
Gil, ml	40	-
Emulsion, ml	40	-
Water, ml Electric Probe Test, time for	40	See Chapter 2
water separation, min	0.2	Test E-4
Material Compatibility Static 20KPS1*	""	See Chapter 2
Buty1	Poor	Test C-3
Buna N	Good	-
Viton B	Good	-
Ethylene-Propylene	Poor	-
Tetrafluoroethylene (Teflon)	Good	-
Neoprene	Fair	-
Throkol		-
Silicone	Fair Fair	-
Fluorosilicone * Based on atmospheric pressure data,		<u> </u>

Fluorosilicone

* Based on atmospheric pressure data.

and the second s		<u> </u>	7	1	Method
Volutility		j			metho 1
Toxicity	Petroleum		[[
Density, grams/cubic centimeter, at:	35° 1	100 F	† 156° I	†	. •
0 psig	0.7947	0.8700	0.8511	J	See NSRDL
5,000 psiq	0.1037		0.8636	ĺ	Annapolis Report
5.000 paig	0.1093		0.8711	[MATLAM N. O. C. BALLAM
8,000 psig	0.9169		0.8312		1
10,000 psig	0.9216	0.9006	0.8871	İ	ĺ
16,000 psig	0.9325		0.8995		
20,000 psig	0.9421	0.9174 90° F	0.9103		1
Isothermal Compressibility, volume decreuse, %, at:	31 V F	90° F	11.0 F	İ	
O psiq	1		! !	ł	See NSPDL
3,000 psiq	, , , ,		1 [Annapolis Report
5,000 psiq	1.00	1.12	1.45		MATLAB 🦥 (
8,000 paid	2.42	1.84 2.73	2.30 3.41		Ì
10,000 psiq	2.92	3.29	4.06		
15,000 psig	4.03	4.50	5.38		1
20,000 psig	5.03	5.53	6.50		1
Chemical Stability	+		<u> </u>		-
Oxidation Stability Test, 203° F.	1		Į i		ASTM D=943
hours to failure					
Oxidation Stability Test, 250° F	1	1			Fed. Method 5308
Hydrolytic Stability Test] [ĺ		Military specifi-
Specimen change, mg] [j (cation MIL-H-
Specimen appearance	1 1		} [19457в
fluid acid number increase,	1]		-
mg KOH/gram fluid	}	ļ]		1
Water acidity, mg KOH Insolubles, %	1 }	ì	1		1 -
Thermal Stability Test	}	ļ	, ,) -
Fire Resistance	} {	}) -
Flash Point, °F	305	}			10 mm 5 ()(
Fire Point, °F	325 345	}			ASTM D=9% ASTM D=9%
Autogeneous Ignition Temperature.°					ASTM D-2155
High-Pressure Spray Combustor	1 1	ļ	1		Sec MEL Report
Minimum spontaneous ignition	1	İ	· •		51/66 of March
temperature, °F	1 1	İ	1		1967
Minimum reaction temperature,	1 1	ł	1		-
°F		1	l.		1
No indication of fire, °F	1 1	1	1		-
Maximum pressure change, psi	1 1	1	Ì		-
Lowest temperature of maximum	1 1	[{		-
pressure change, °F			{		
Temperature range explored, °F	1	í	(-
Pour Point, F	1	ĺ			
Foaming Tendency, 75° F	<-40	{	{		ASTM D-07
Foam after 5-minute aeration,	1 22	}	ł		ASTM D+8 Y
ml	<10	}	ł		-
Time out, minutes			į		
Foam after 10-minute settling,			1		1 -
ml	1				
Neutralization Number, mg KOH/gram	0.01	1	1		ASTM D-MM
Water Content, % by weight	0.007	1			ASTM D-1744
Neutrality, qualitative	Neutral	1	1		Fed. Method : 111
Contamination		}	}		-
Number and size of particles and	4)	ļ	1		SAE Method ARE-
fibers in 100-ml fluid])	1	}		ins.
25-100 micrometers	1	j	1		_
100-500 micrometers))]		-
over 500 micrometers)	-	1		-
particles over 250 microm-	1	})		-
eters except fibers (length	ļ ļ	ļ	1		
ten times diameter)]		Ì		
Gravimetric Value, mg/100 ml	1	1	ļ		SAE Method ARP =
Color	1	-		ļ	ACOM D. Levis
CO101		I	1		ASTM D-1905
nst . \$/gal	\$ 70 I	- 1	1	1	1
ost, \$/gal vailability	\$.70 Govt spec	[-

Determinations made at atmospheric pressure, unless noted. Heavy deposits indicate corrosion not shown by weight change. Saturated with seawater.

Supplementary Properties of VV-1-530a

		Method
Material Compatibility with: *		See Chapter 2
Buna S	Poor	Test C-3
Natural Rubber	Poor	ĺ
Polyurethane	Good	
Miscellaneous Properties		[
Specific Gravity at 50/60° F	0.88	ASTM D-1298

* Bused on atmospheric pressure data.

VV-D-001078 (10 CS)

Suggested Uses and Possible Limitations

The fluid covered by Federal Specification VV-D-001078 is a dimethyl polysiloxane developed for use as a damping fluid and is available in viscosities from 0.65 to 200,000 centistokes. The VV-D-001078, 10-cs fluid can be used as an immersion medium for nonmoving equipment and has a depth capability of 16,000 feet. It has poor sea-water corrosion inhibition capability. Its high compressibility must be considered in system design. The poor lubricating ability (particularly with steel-on-steel components) of silicone fluids limits its application to nonmoving components. Although this fluid has been used in deep submergence electrical applications, it is considered a questionable choice for electrical usage because of borderline dielectric breakdown voltage.

Properties of VV-D-001078 (10 cs) (1) (Silicone Fluid)

	(3.110	ove Linia	<i>'</i>		
f					Method
Viscometric Properties	ł		[
Viscosity, centistokes, at:	_ 55° ₽	100° F	1'.0° F		İ
() psiq	17.86	8.66	4.75		
5,000 paig					See ESEDL
	25.67	12.57	8.30		
5,000 parq	31.98	14.99	10.11		Annapolis Report
8,000 psig	44.45	20.16	12.63		MATIAB 350
10,000 parq	49.44	23.82	15.00		-
15,000 psig	78.64	35.52	21.90		ļ -
70,000 psig	123.5	51.12	30.55		-
•		•			
					1
		1			
]			
Viscosity, centistokes, at 210° F,	3.76				ASTH D-445
•				_	
0 psig	0.430			•	
Viscosity Slope, ASTM					<u> </u>
Lubricating Ability					_
4-Ball Wear Test, 30 min, 50° C.					Fed. Method 6503
52100 steel, average scar dia.,					(modified)
.am:	<u> </u>				,
1 kg]		·		_
					_
3 kg					-
5 k g					 -
]
					t
					l .
					ł .
Corrosion Protection					
Stirred Rust Test, 10% seawater,	Fail				ASTM D-665
140° F, 2 days					
On-Off Rust Test, 50% seawater,					See Chapter 2
	Fail				
140° F. 30 days					Test C-5
Ambient Pressure, coupon					See Chapter ?
stirred, corrosion test, weight	1				Test C-1
change, mg	l i				ĺ
Copper					l _
	-1.7				_
Stainless Steel, 316	+7.7	i	i	!	-
Copper-Nickel (70-30)	+14.2] -
Aluminum, QQ-A-250-4b	-198.9				-
Phosphor-Bronze	-63.4				-
Steel, galvanized	-97.6		ļ		l -
Steel, 1009	1009.8		, [l _
Aluminum, QQ-A-250-11		į	,		1
	+210.9				l -
Bronze	-1.4				-
Monel	+11.3		l		-
Silver Base Brazing Alloy	+19.2				
20,000 PSIG Pressure-Cycled					See Chapter ?
Corrosion Test (1% seawater),		1	1		Test C-2
•			l		1-3-6-2
weight change, mg			l		
Insulated Specimens:					
Copper					-
Stainless Steel, 316	l l				_
Copper-Nickel (70-30)		1			_
Aluminum, QQ-A-250-40	Į				
Phosphor-Bronze					_
					-
Steel, galvanized	Į l	į			-
CANAL HACO					l -
Stecl, 1009		f	I	i	
Aluminum, QQ-A-250-11		ĺ			-
Aluminum, QQ-A-250-11					-
Aluminum, QQ-A-250-11 Bronze					- -
Aluminum, QQ-A-250-11				·	-

	·		,	
]	ł	Method
Corrosion Protection (Cont)		ł	1	
Electrically Coupled Specimens:	: [j	-
Copper-Atuminum, QQ-A-250-11	1			-
Aluminum QQ-A-250-4b -				-
Copper-Nickel (70-30)	i			
Hone 1 - Bronze				_
				_
Stainless Steel (316) -]	-
Phosphor-Bronze				
Silver Base Brazing Alloy -	1			-
Steel, 1004				
Aluminum QQ-A-250-11 -				-
Bronze				
Aluminum QQ-A-250-4b -				_
				-
Steel, 1009				
20,000 PSIG Stirred Corrosion				See Chapter?
Test, weight change, mg				Test C-4
Insulated Specimens:				
Copper				-
Stainless Steel, 315				_
Copper-Nickel (70-30)				
				-
Aluminum, QQ-A-250-4b				-
Phosphor-Bronze	[-
Steel, galvanized]			-
Steel, 1009				-
Aluminum, QQ-A-250-11				_
				_
Pronze	·			•*
Monel	į			-
Silver Base Brazing Alloy	ļ			-
Electrically Coupled Specimens:	ł I			
Copper-Aluminum, QQ-A-250-11				_
Aluminum, QQ-A-250-4b -			l i	_
	i			
Copper-Nickel (70-30)				
Nonel-Bronze				-
Stainless Steel (316) -				-
Phosphor-Bronze	1		· ·	
Silver Base Brazing Alloy -				_
Steel, 1009				
Aluminum, QQ-A-250-11 -				! -
Bronze			'	
Aluminum, QQ-A-250-4b -				-
Steel, 1009				
Pump Test				Proposed military
•				specification for
Average Weight Loss, mg				sea-water emulsi-
Steel Gears				
Bronze Bushings				fying oils
Corrosion Coupons, weight loss,	.[
each, mg/cm ²	1			
Copper	1			-
Aluminum	1	-	ļ l	1 _
			i l	
Steel, galvanized			l	-
Steel, 1009	1			-
Silver Base Brazing Alloy				-
Dielectric Properties				ASTM D-1169 (mod-
Resistivity, EC F, ohm-cm:				ified). See Chap-
As-Received	3.6x10 ¹⁴			ter 2. Test E-1
	8.6x10 ¹³			
With Sea-Water Con-	0.0XI0->			See Chapter 2
tamination:(2)				Test E-5
0.5% by volume	}			-
2.0% by volume		i	i	_
With Carbon Con-	1			Con Chanter C
				See Chapter 2
tamination:				Test E-6
0.25% wt/vol.	1			-
0.5% wt/vol.				

			Method
Dielectric Properties (Cont)			FIC CHOO
Attento, OCO Electric Aics	1		See Chapter 2
(makes and breaks) at 40	ĺ		Test E-7
volts, 10 amperes, resear			1
tive loat			
Not filtered			i -
Filtered	i		-
Solids generated, gram	ļ		Con Chanter 2
Dissipation Factor, 80° F, C			See Chapter ? Test E-2
As-Roce ived	0.0		See Chapter 2
With Sca-Water Con- tamination:(C)	0.7		Test E-5
0. A by volume		l i	1
2.0% by volume	1		
With Carbon Contamination:			See Chapter ?
0.10% wt/vol.			Test E-6
O.The wt/vol.			
0,50% wt. vot.			-
After 10,000 atectric Acco			
(makes and breaks) at 90	1		
volts, 10 amperes, rish-			
tive load	1		
Not filtered) <u>1</u>] -
Filtered	1		-
Solids generated, mon	}		-
Dielectric Breakdown Voltage,			ASTN D-877 (mod-
0.05-inch sap, 80° F, kv			ified). See Chap-
As received	14.8		ter 2. Test E-5
With sea-water con-	5.8		See Chapter 2
tamination:(2)			Test E-5
0.5% by volume			-
2.0% by volume			-
With carbon contamination:			See Chapter 2
0.10% wt/vol.	1		- Test E-6
0.25% wt/vol.			-
0.50% wt/vol.	1		-
After 50,000 electric	!		
(makes and breaks) at a volts, 10 amperes, recom-	ì		
tive load	j		
Not filtered	•		_
Filtered	1		1]
Solids generated, pro-	1		
Contact Life, silver-cadmium, 'C	1		See Chapter 2
volts, 10 amperes, resisting	İ		Test E-8
load, 6000 psi, 65°-85° F			
Number of tests	1		1 -
Operations to failure (Faile)			1
Emulsion Stability	1		1
Paddle Test, after 1-hour set-	i		ASTM D-1401
tling:			!
Gil, ml	40		1 - 1
Emulsion, ml	0		[-
Water, ml	40		1 1
Electric Probe Test, time to:	0		See Campter ?
water separation, min			Test E-4
Material Compatibility Static 2CKPSI			See Chapter 2
Butyl	Poor-Fair		Test C-3
Buna N	Fair		[-
Viton B	Good		-
Ethylone-Propylene	-		1 - 1
Tetrafluorocthylene (Teflon)	Good		, ~ .
Neoprene	Fair		j - !
Thiokol	Good		-
Silicone	Poor		[-
Pluorosilicone Rased on atmospheric pressure data	L Poor		<u> </u>

					Method
Volatility	1			Į.	
Toxicity	Silicone				_
Density, grams/cubic centimeter, at:	35° F	100° F	150 1	1	
0 psig	0.9572	0.9238	0.8973	1	See NSRDL
5,000 psiq	0.9788	¢.9514	0.9313		Annapolis Report
5,000 psig	0.9924	0.9663	0.9484		NATLAB 350
8,000 psig	1.0095	0.9859	0.9708		l
10,000 рыід	1.0062	0.9976	0.9851		
15,000 parq	1.0892	1.0206	1.0092		
20,000 psig	1,1093	1.0404	1.0314		
isothermal Compressibility, volume	35° F	90° F	150° F		
decrease, %, at:					See NSRDL
O paig					Annapolis Report
3,000 paig	1.88	2.11	5.62		MATLAB 350
5,000 psig	2.97	3.38	4.02		
8,000 psiq	4.40	4.95	5.72		
10,000 paig	5.21	5.82	6.75		ì
15,000 psig	5.98	7.66	8.74		İ
20,000 psiq	8.49	9.22	10.52		
Chemical Stability			,		30m. n 01:4
Oxidation Stability Test, 203° F,					ASTM D-943
hours to failure	ł				m. a 11-a)-a (200
Oxidation Stability Test, 150° F	1				red. Method 5308
Hydrolytic Stability Test	1				Military specifi-
Specimen change, mg					cation MIL-H-
Specimen appearance					19457в
Fluid acid number increase,	ļ				'
mg KOH/gram fluid			1		ļ
Water acidity, mg WOH					-
Insolubles, \$			i		-
Thermal Stability Test			l		~
Fire Resistance	l				ASTN D-92
Flash Point, F	355		1		ASTN D-92
Fire Point, *F	415		1		· · · · · · · · · · · · · · · · · · ·
Autogeneous Ignition Temperature, or			l		ASTM D-2155 See MEL Report
High-Pressure Spray Combustor					51/66 of March
Minimum spontaneous ignition temperature, *F			•		1967
Minimum reaction temperature,			Ì		1901
*F			İ		-
	İ		ł		
No indication of fire, °F			ĺ		-
Maximum pressure change, psi					-
Lowest temperature of maximum pressure change, *F	i		1		-
	1				
Temperature range explored, °F					- 1
Niscellaneous Properties Pour Point, F			1		ASTM D-97
Foaming Tendency, 75° F	<-65				ASTM D-892
Foam after 5-minute aeration,			j		ASTA Days
ml	0		!		_
Time out, minutes			ļ		
Foam after 10-minute settling,	-		ĺ		
ml	j				-
					ASTM D-974
Neutralization Number, mg KOH/gram Wcter Content, % by weight	0.010	1			ASTM D-974 ASTM D-1744
Neutrality, qualitative	V.(11)				Fed. Method 5101
Contamination	1		ľ		- Ted. Hetilod Jiel
Number and size of particles and	.l				SAE Method ARP-
fibers in 100-ml fluid]		l		598
25-100 micrometers					
100-500 micrometers	1		1		_
over 500 micrometers					_
particles over 250 microm-					
eters except fibers (length	1				
ten times diameter)	1				
Gravimetric Value, mg/100 ml				.	SAE Method ARP-
			t		785
Color	1		!		ASTM D-1500
Cost, \$/gal	\$20.00		l		
Availability	Govt spec				

Availability ROYE Speu

Determinations made at atmospheric pressure, unless noted. Saturated with seawater.

Supplementary Properties of VV-D-001078 (10 CS)

Material Compatibility with: Buna S Polyurethane	Poor Fair	Nethod See Chapter 2 Test C-3
Specific Gravity at 60/60° F	0.941	

Based on atmospheric pressure data.

VV-D-001078 (50 cs)

Suggested Uses and Possible Limitations

The fluid covered by Federal Specification VV-D-001078 in the 50-cs viscosity has been used in the missile hold-down system in submarines. The VV-D-001078, 50-cs silicone fluid can be used as an immersion medium for equipment to a depth capability of 1000 feet. The fluid lacks adequate sea-water corrosion inhibition. Its high compressibility must be considered in system design. The poor lubricating ability (particularly with steel-on-steel components) limits its use. Due to a low dielectric breakdown voltage and poor sea-water emulsion stability and relatively high viscosity, this fluid is not recommended for any electrical applications.

Properties of W-D-CO1078 (50 CS) (Silicone Fluid)

Viscometric Properties					Fe*bod
Viscosity, centistokes, at:	ri,º F	100	11 17		
6, 1211					
*,000 (isi)			ļ		See NSKDU
6,000 ps/1)	į		Annapolis Repor
8,000 ps:j 10,000 ps:g			i		MATLAB 550
10,000 psiq		}			} <u>*</u>
00,000 psig			ļ		
t c jeur p,		ł	}		
		l i	1		
f		[[l		İ
· ·		1 1	-		Ì
			İ		
		1 1			
Viscosity, centistokes, at 7" 1.	50	1	ļ		ASTM D-445
0 psig		[(
Viscosity Slope, ASTM		L	i	· · ·	1 -
Lubricating Ability		1	i		
4-Ball Wear Test, 30 min, '0° 0, 52100 steel, average scar dia.,		1 1			Fed. Method 657 (modified)
mm:		1	!		(modified)
î ku		[[į		
3 kg		1 1	- 1		-
5 kg			,		-
İ		[[1		
		}	ļ		
		[]			
		i	ļ		
Corresion Protection]			
Stirred Rust Test, 10% seawater,	Fail]]	Į		ASTM D-665
140° P, 2 days On-Off Rust Tes*, 50% seawater,					222 01211
140° F, 30 days	Fail		1		See Chapter 2 Test C-5
Ambient Pressure, coupon		i !			See Chapter 2
stirred, corrosion test, weight					Test C-1
change, mc		1 (
Copper]	j		- 4
Stainless Steel, 316					_
Copper-Nickel (70-30)) !	ļ		-
Aluminum, QQ-A-250-4b					-
Phosphor-Bronze Steel, galvanized		1			1 -
Steel. 1009				Í	
Aluminum, QQ- A -250-11		[1 -
Bronze					_
Monel					-
Silver Base Brazing Alloy		!	j		
20,000 PSIG Pressure-Cycled					See Chapter 2
Corrosion Test (1% seawater),			İ		Test C-2
weight change, mg Insulated Specimens:		1	1		1
Copper					_
Stainless Steel, 316					-
Copper-Nickel (70-30)					-
Aluminum, QQ-A-250-4b] [-
Phosphor-Bronze					-
Steel, galvanized					į -
Steel, 1009			ļ		-
Aluminum, QQ-A-250-11 Bronze					-
DIGITEC			J		, -
Monel		1	1		l -

i,

	7	1	1	T	Mathod
Corresion Protection (Cont)	ĺ	ĺ	[í	
Electrically Coupled Specimener		1		}] -
Copper-Aluminum, QQ-A-250-11	L]	1	1	j] -
Aluminum QQ-A-250-4b -	1				-
Copper-Nickel (70.50)	}		1	J]
Monel-Bronze	1	Į] -
Stainless Steel (516) -	}	}	}	1] -
Phosphor-Bronze	Ì]]	j	1
Silver Base Brazing 'lloy -	1		j	1	ļ -
Steel, 1004	}		j]	j
Aluminum (2-A-250-)1 -	İ	1		1	-
Bronze	ì	}	ļ	1	!
Aluminum (Q-A-250-4b -	1	1	j	İ	ļ -
Steel, 1009	ì	1			Ì
20,000 PSIG Stirred Corrosion	}	1	}	J	See Chapter ?
Test, weight change, mg	1	1	1	ļ	Test C-4
Insulated Specimens:		1]
Copper	1	!	i		-
Stainless Steel, 316	1	1	1	ļ	-
Copper-Nicke! (70-30)		j]		l -
Aluminum, QQ-A-250-4b		İ			 -
Phosphor-Bronze	1	ļ	1	j	
Steel, galvanized	ļ		j		-
Steel, 1009	1	ļ	1	ļ	j -
Aluminum, QQ-A-250-11		:			_
Bronze		1	1		-
Monel)	}	j	j] -
Silver Base Brazing Alloy	1	į	į	ļ	-
Electrically Coupled Specimens:		}	j	ļ	ļ
Copper-Aluminum, Qu-A-250-11	L]		1		-
Aluminum, QQ-A-250-1b -			[[
Copper-Nickel ('V)	İ		1		
Monel-Bronze		1	1		-
Stäinless Steel (316) -			1		-
Phosphor-Bronze					
Silver Base Brazing Alloy -		1	1		-
Stecl, 1009	j	ļ	1	1	
Aluminum, 90-A-250-11 -	•	Į	Ì	1	-
Bronze	1			j	
Aluminum, $QQ=A=250=4b=$	ì	l		j	-
Steel, 1009		i	ĺ	[
Pump Test		1	ļ	İ	Proposed militar
Average Weight Loss, mg	1	[specification fo
Steel Gears	1	}	j	ļ	sea-water emulsi
Bronze Bushings	1	1			fying oils
Corrosion Coupons, weight loss,	.[1	1	(
each, mg/cm ²			}		
Copper	-	1	ļ		-
Aluminum	j]	j]	· -
Steel, galvanized		1	1		-
Staml, 1009	[[1	!	-
Silver Base Brazing Alloy		l			-
Dielectric Properties	1		ĺ		ASTM D-1169 (mod
Resistivity, 77° F, ohm-cm:		1			ified). See Chap
As-Received	7.8×1013				ter 2. Test E-1
With Sea-Water Con-	14.4×1013		[See Chapter 2
tamination:(2)	1		{		Test E-5
0.5% by volume			1	ĺ	-
2.0% by volume	1				-
With Carbon Contamination:	1		[See Chapter 2
0.1% wt/vol.	{		[Test E-6
0.25# wt/vol.					+ 1081 N=U
0.5% wt/vol.	j		!	Ì	-

	Method
	Charter D
	See Chapter 2
	Test E-7
1	
	See Chapter ?
	Test E-2
1	See Chapter 2
0.9	Test E-5
1	See Chapter 2
	Test E-6
	1 esc E-0
	_
	· [.
1	
1	-
	-
	-
	ASTM D-877 (mod-
	ified). See Char
6.3	ter 2. Test E-3
6.1	See Chapter 2
	Test E-5
1	-
	-
	See Chapter 2
	Test E-6
]	-
1	
i	
	-
	-
1	See Chapter 2
	Test E-8
1 1	
1 1	
	20mm p 1/101
	ASTM D-1401
1 40	
1	-
, ,	1 1 -
1	See Chapter 2
'	Test E-4
.	See Chapter 2
Poor-Fair	Test C-3
1	
1 1	
5554	
Good	
1 1	
1 1	
Poor	
	40 0 40 3 Poor-Fair Fa.r Good Fair Good

	1	<u></u>			Method
Volatility	{	[!		Amagana a a a a a a a a a a a a a a a a a
Toxicity	Silicone	İ	1 1	i	_
Density, grams/cubic centimeter, ati	35	100 F	7760 F		recent or the contract of
0 psig					See NSKOL
3,000 paig	İ	ľ	1		Annapolis Report
5,000 psiq	1	İ			MATLAB 510
8,000 psiq	1	1	1		
10,000 psig	İ	f	(
15,000 psig	Ì	ļ			
20,000 psiq		ì	į į		ľ
Isothermal Compressibility, volume	35° F	100° F	T OF F		a magazina a a a a a a a a a a a a a a a a a a
decrease, %, at:		 			See NSRDL
0 psiq	1		i i		Annapolis Report
3,000 paid			!	:	MATLAB 550
5,000 psig		[ĺ		, ,
8,000 psiq	ł	1	!		
10,000 psiq		1			
15,000 psig			1 1		
20,000 psiq	ł	i			!
Chemical Stability	 				
Oxidation Stability Test, 203° F,	İ	ĺ			ASTM D=3431
hours to failure	1				, ,
Oxidation Stability Test, 250° F	([[Fed. Method 1308
Hydrolytic Stability Test	ł	ł	}		Military specifi-
Specimen change, mg		ł			cation MIL-H-
Specimen appearance	{	ĺ	(1941 7B
Fluid acid number increase.	ł	1	1		1
mg KOH/gram fluid		1			_
Water acidity, mg KOH		1			_
Insolubles, %	{	 	i		_
Thermal Stability Test	 	ļ '			
Fire Resistance	ľ	1	ľ		_
Flash Point, °F	Seze	1	ł i		ASTM D-92
Fire Point, °F	>535		[ASTM D-92
Autogeneous Ignition Temperature, °F		i ,	{ i		ASTM D-2155
High-Pressure Spray Combustor	ļ	ļ			See MEL Report
Minimum spontaneous ignition	ł	!	i		31/66 of March
temperature, °F	i				1967
Minimum reaction temperature,	ļ		1		1 -
° p	1		}		_
No indication of fire, °F	ł	}	}		
Maximum pressure change, psi	1	i '			
Lowest temperature of maximum	ł		1		
pressure change, °F	ł	}	}		_
Temperature range explored, °F	1				_
Miscellaneous Properties	ł	ļ			_
Pour Point, F					ASTM D-97
Foaming Tendency, 75° F	<-65	}	1		ASTM D-892
Foam after 5-minute aeration,	}		!		
ml	1				
1	1		{		
Time out, minutes	}	}	}		_
Foam after 10-minute settling,			ĺ		-
ml Neutralization Number mg KOH/gram	1		}		ASTM D-974
Neutralization Number, mg KOH/gram	1		}		ASTM D=974 ASTM D=1744
Water Content, % by weight Neutrality, qualitative		ļ	ļ ļ		Fed. Method 5101
Contamination	1	}	}		
	J				SAE Method ARP-
Number and size of particles and fibers in 100-ml fluid	1	!	<u> </u>		598
25-100 micrometers	i		į ł		- J7V
100-500 micrometers	1		ļ		_
over 500 micrometers	1		! 1		_
j -	ł		}		_
particles over 250 microm-	1				-
eters except fibers (length	}		}		
ten times diameter)	1]		SAE Method ARP-
Gravimetric Value, mg/100 ml	1				785
G-10#	1	}			ASTM D-1500
Color	415 60]		Potty D=1°0/.
Cost \$/gal	\$15.00				-
Availability	IGOVE apac	L	L		

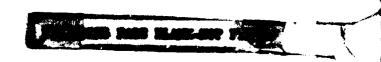
Availability Govt aped

Determinations made at atmospheric pressure, unless noted. Saturated with seawater.

Supplementary Properties of VV-D-001078 (50 cs)

		Me thod
Material Compatibility with:		See Chapter 11
Polyurethane	Poor Fair	Test C.3
Miscellaneous Properties Specific Gravity, 60/50° F	0.961	ASTM D-1293

Based on atmospheric pressure data.



MILITARY SPECIFICATION PRODUCTS

MIL-H-5606B

Suggested Uses and Possible Limitations

The fluid covered by Military Specification MIL-H-5606B is a petroleum-base, low-viscosity fluid which has been used extensively in aircraft and missile hydraulic systems. The properties of MIL-H-5606B indicate that it is suitable for use as hydraulic fluid, as a motor immersion fluid, as a general lubricant, and for environmental protection of electrical equipment at depth capability of 20,000 feet. Its limitations are lack of corrosion protection, poor sea-water compatibility, and its high flammability. There are reported field application failures due to formation of large carbon deposits under pressure in electric arcing conditions; however, this problem is common to all hydrocarbon fluids. (See Chapter I.) Its combination of good sea-water emulsion stability, good dielectric properties, and intermediate viscosity makes this fluid the best choice known to date for electric motor usage and a moderately good choice for all other electrical applications.

Properties of NIL-H-5606B(1) (Petroleum Base Fluid)

	1				Method
Viscometric Properties					
Viscosity, high shear, cs. at:	51,° F	100° F	150° F		1
C parq	29.85	12.26	7.21		{
5,000 psig	43.44	16.31	9.74		See NSRDL
5,000 parq	52.89	19.21	11.39		Annapolis Report
8,000 patq	76.16	24.90	14.24		HATLAB 550
10,000 parq	92.62	29.32	16.07		-
15,000 paid	152.8	42.90	55.88		-
20,000 paid	264.4	62.55	31.65		-
Viscosity, low shear, cs, at:	35° F	100° F	150° F		İ
0 psiq	40.50	13.80	8.60		
3,000 psig	60.55	18.39	11.53		
5,000 psig	86.66	21.87	14.01		1
8,000 paig	113.4	32.33	18,82		
10,000 psig	147.1	59.78	23.53		į
15,000 psig	270.5	58.41	35.07		
20,000 psig	504.8	92.59	52.38		acoma is little
Viscosity, centistokes, at 210° F.					ASTH D-445
0 pstq	5.16	-	-		1
Viscosity Slope, ASTM	0.457				↓
Lubricating Ability					Did Washed (101
4-Ball Wear Test, 30 min, 50° C,			`		Fed. Method 6505
52100 steel, average scar dia.,					(modified)
mm: 1 kg	1				1
3 kg	0.19	!			ļ -
5 kg Rolling Contact Fatigue Test, hr:		-	-		-
	34.9				-
BlO life: Dry With 1% synthetic	12.7				i
• -	12.7		Į		
seawater	94.3				
B50 life: Dry	35.8(4)				
With 1% synthetic	25.00				1
seawater					1
Stirred Rust Test, 10% seawater,	Fail		İ		ASTM D-665
140° F, 2 days	1		ļ		A3111 D-003
On-Off Rust Test, 50% seawater,	Fail				See Chapter 2
140° F, 30 days	Fall		1		Test C-5
Ambient Pressure, coupon					See Chapter 2
stirred, corrosion test, weight	-	ļ			Test C-1
-	İ				1 1000 0-1
change, mg	-4.1		i		1_
Copper					1]
Stainless Steel, 316 Copper-Nickel (70-30)	+0.1				1 _
Aluminum, QQ-A-250-4b	1		l		
Phosphor-Bronze	+0.7				1 -
Steel, galvanized	-116.5		1		1 -
Steel, 1009	-110.8				1 -
Aluminum, QQ-A-250-11	+0.6				1 -
Bronze	+2.1				-
Monel	+0.2		i		l <u>-</u>
Silver Base Brazing Alloy	-0.7				
20,000 PSIG Pressure-Cycled					See Chapter ?
Corrocion Test (1% seawater),	1 -				Test C-2
weight change, mg	1				
Insulated Specimens:	I				1
Copper	-0.2				-
Stainless Steel, 316	+0.1				1 -
Copper-Nickel (70-30)	+0.1				1 -
Aluminum, QQ-A-250-4b	0				1 -
Phosphor-Bronze	-0.2				1 -
Steel, galvanized	+0.3				1 -
Steel, 1009	+0.1				1 -
Aluminum, QQ-A-250-11	+0.1				1 -
Bronze	0.1				J _
Monel	l ŏ				-
		l	l	,	1_
Silver Base Brazing Alloy	1 0	1			

crowton Bustnetton (Cont.)		ŀ		Method
rosion Protection (Cont) Electrically Coupled Specimens:		1		
Copper-Aluminum, QQ-A-250-11		-0.1		-
, ,	+0.2	0		-
Aluminum VQ-A-250-4b -	₩.2	1 "	ļ	į -
Copper-Nickel (70-50)				
Monel-Bronze	+0.1	+0.2		•
Stainiess Steel (516) -	+0.2	0		-
Phosphor-Bronze	_	1		1
Silver Base Brazing Alloy -	0	+0.2		
Steel, 1004		1		
Aluminum QQ-A-250-11 -	+0.1	+0.2		-
Bronze		1		
Aluminum QQ-A-250-4b -	+0.2	+0.1		
Steel, 1009	1	1		
10,000 PSIG Stirred Corrosion	ļ	1		See Chapter ?
Test, weight change, mg	1	i		Test C-4
Insulated Specimens:		1		
Copper	-2.6	1		
Stainless Steel, 316	0			<u> </u>
Copper-Nickel (70-50)	٥	İ		
Aluminum, QQ-A-250-4b	-1.9			
Phosphor-Bronze	-2.1	1		-
Steel, jalvanized	-0.1			1 -
Steel, 1009	-18.8	1		*
	1			-
Aluminum, QQ-A-250-11	-0.1	ļ		<u> </u>
Bronze	-2.5		1	j -
Monel	0	į.	j j	
Silve: Base Brazing Alloy	-0.4			-
Electrically Coupled Specimens:	I .	1		1
Copper-Aluminum, QQ-A-250-11	-2.0	+0.1		-
Aluminum, QQ-A-250-4b -	+0.2	0		-
Copper-Nickel (70-30)		1		
Monel-Bronze	+0.2	-2.6		-
Stainless Steel (316) -	+0.1	-3.1	Ì	-
Phosphor-Bronze				
Silver Base Brazing Allo: -	-0.3	-11.1	1	
Steel, 1009	'''			
Aluminum, QQ-A-250-11 -	+0.2	-2.7		<u> </u>
Bronze	10.2	1 -2 . /		ļ
Aluminum, QQ-A-250-46 =	-0.6	-15.4	1	_
Steel, 1009	30.6	-15.4	1	
				Proposed milita
Pump Test	!			specification
Average Weight Loss, mg	١.,٠			sea-water emul:
Steel Gears	15			ı
Bronze Bushings	9			fying oils
Corrosion Coupons, weight loss,	}			
each, mg. cms				
_obb∈ r	0.01			-
Aluminum	0.04	ļ		-
Steel, galvanized	0.01	İ		-
Steel, 1009	0.03			-
Silver Base Brazing Alloy	0.02	ļ		 -
electric Properties	!		†	ASTM D-1164 (mc
Resistivity, 77 F, ohm-cm:				ified). See Chi
As-Received	5.0x10 ¹²			ter . Test E-
With Sea-Water Con-	₩.6×10 ¹²		1	See Chapter 2
tamination:(3)	İ			Test E-5
0.5% by volume	į			- Year E-2
2.0% by volume	1			-
With Carbon Contamination:				Sec. (2)
0.1% wt vol.	1			See Chapter 2
	1	1		Twat E-b
0.25 4 wt vol.	i	į ·		I -

		T	· r · · · · · · · · · · · · · · · · · ·	T	Method
Dielectric Properties (Cont)					Retiled
Atter 50,000 Electric Ares	i	1	İ		See Chapter 2
(makes and breaks) at 90	1				Test E-7
volts, 10 amperes, resis-	ľ	1	1		1686 5-1
tive load	ŀ	İ	I	}	1
Not filtered	8-0x1011	1	i	1	1
Filtered	8.6x1011			1	-
Solids generated, gram	0.81	1	i i	1	-
Dissipation Factor, 77° F. *	1	1			Sun Chauten S
As-Received	2.0	1	1	1	See Chapter ?
With Sea-Water Con-	2.0	1	1		Test E-?
tamination: (3)	2.1	1	ł		See Chapter 2
0.5% by volume	1		1		Test E-5
· · · · · · · · · · · · · · · · · · ·	1	l	1		15 4
2.0% by volume	1	j .	1		
With Carbon Contamination; •	ł	l			See Chapter 2
0.10% wt/vol.		1		1 2 .	j` fesi∯E-6
0.25% wt/vol.	1	l	ł	1	1
0.50% wt/vol.	1	J	ļ].] -
After 50,000 Electric Ares		1			i
(makes and breaks) at 90	J	J	l .	}	1
volts, 10 amperes, resis-	1	1			1
tive load]	j	}]	1
Not filtered	0.8	1			i -
Filtered	0.5		j		! -
Solids generated, gram		1		1	! -
Dielectric Breakdown Voltage,				1	ASTH D-877 (mod-
0.05-inch gap, 77° F, kv	1	1			ified). See Chap-
As received	23.8	1		1	ter 2 . Test E-3
With sea-water con.	7.2		ì		See Chapter 2
tamination:(3)	1	İ			Test E-5
0.5% by volume		İ			1 - 1000
2.0% by volume	İ	ľ			1 _
With carbon contamination:					
0.10% wt/vol.	1	l			See Chapter ?
0.25% wt/vol.		1			Test E-6
0.50% wt/vol.		ł	ì	l	<u> </u>
After 50,000 electric arcs		1]		-
(makes and breaks) at 90		l	ł	i	i
volts, 10 amperes, resis-			l		!
tive load	t				
Not filtered					
	10.8	l	1		-
Filtered	15.8	i	1		<u> </u>
Solids generated, gram	1	l	l		
Contact Life, silver-cadmium, 50		1			See Chapter 2
volts, 10 amperes, resistive	1	1	l	•	Test E-8
load, 6000 psi, 65°-85° F	1	1	}]]
Number of tests	Į	1	1		-
Operations to failure (range)	1	}	j		
Emulsion Stability	1	l			
Paddle Test, after 1-hour set-	J	j	1		ASTM D-1401
tling:	1	1	i		
Oil, ml	33	l			<u> </u>
Emulsion, ml	30	l			•
Water, ml	14	ļ]		-
Electric Probe Test, time for	10	l	1		See Chapter 2
water separation, min	ļ	l			Test E-4
Material Compatibility Static 20KPSI	4			<i>:</i>	See Chapter 2
Butyl	Poor	ĺ			Test C-3
Buna N	Fair-Good		1		
Viton R	Good	l	1		_
Ethylene-Propylene	Poor		Į į		_
Tetrafluoroethylene (Teflon)	Good		1		
Neoprene	Fair		1		
Thiokol	1		1		_
Silicone	Poor				Ĩ
Fluorosilicone	Poor				'
					-

^{*} Based on atmospheric pressure data.

Flash Point, °F Fire Point, °F Autogeneous Ignition Temperature, °F High-Pressure Spray Combustor Miniamm spontaneous ignition temperature, °F Minimum reaction temperature °F Mo indication of fire, °F Maximum pressure change, ssi Lowest temperature of maximum pressure change, rsi Lowest temperature arange explored, °F Temperature range explored, °F Poaming Tendency, 75° F Foam after 5-minute aeration, ml Time out, minutes Foam after 10-minute settling, ml Neutralization Number, mg NOH/gram Water Content, % by weight Neutrality, qualitative Contamination Number and size of particles and fibers in 100-ml fluid 25-100 micrometers over 500 micrometers over			<u> </u>			Method
Density Gream/cubic centimeter, at 0.5 r 100° r						
0 psig			1			
3,000 psis 5,000 psis 0,000 0,					1	Con NCPDI
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1,000 psis 0,0076	8,000 psig		0.8679		ĺ	[]
### ### ##############################).8957	0.9739	0.8580		!
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1.22 1.29 1.60 MATLAB 350					ļ	
5,000 psis		1.12	1.29	1.60		, , , ,
15,000 paig 15,000 paig 15,000 paig 15,000 paig 15,000 paig 20,000	5,000 paig	1.81	2.07	2.52]
15,000 paig 20,000 paig 20,000 paig 20,000 paig 20,000 stability Oxidation Stability Oxidation Stability Test, 250° P North Stability Test, 250° P North Stability Test, 250° P North Stability Test Specimen change, mg Specimen appearance Fluid acid number, increase, mg NON/Gram floid Mater acidity, mg NOH Insolubles, % Thermal Stability Test Fire Resistance Flash Point, °p Aurogeneous Ignition Temperature, °p High-Pressure Spray Combustor Minimum spontaneous ignition temperature, °p High-Pressure Spray Combustor Minimum reaction temperature °p Move acide to the stability Mater acide to the stability Mater acide to the stability Mater acide to the stability Mater acide to the stability Mater acide to the stability Material to the stability Material to the stability Material to the stability Minimum persours change, nsi Lowest temperature of maximum pressure change, 75° F Miscellaneous Preparties Pour Point, °F Poaming Tendency, 75° F Poam after 10-minute settling, mi Time out, minutes Poam after 10-minute settling, mi Neutralization Number, mg NOH/gram Nature and size of particles and fibers in 100-mil fluid 25-100 micrometers loose to the stability Material value, mg/100 ml Color Gravimetric Value, mg/100 ml Color Cost, 3/vpl Availability 22.60 ASTM D-1500 ASTM D-1500 ASTM D-1500 ASTM D-1500 ASTM D-1500 ASTM D-1500 ASTM D-1500						
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Determinations made at atmospheric pressure, unless noted. Heavy deposits indicate corrosion not shown by weight change. Saturated with seawater. Some rust observed in system.

Supplementary Properties of MIL-H-5606B

Material Compatibility with: " Natural Rubber Buna S	Poor Poor	Method See Chapter II Test C-3
Miscellaneous Properties Specific Gravity	0.86	ASTM D-1298

Based on atmospheric pressure data.

MIL-J-5624F

Suggested Uses and Possible Limitations

The fluid covered by Military Specification MIL-J-5624F is petroleum-base jet engine fuel. The JP-5 grade of the fluid has been suggested for deep ocean applications because of its low viscosity. The few relevant values known for MIL-J-5624F (JP-5) indicate it to be of questionable value for any electrical applications because of low dielectric breakdown voltage. Studies of diesel fuel as a lubricant lead to the prediction that JP-5 would have poor lubricating ability. It lacks corrosion inhibiting properties and is also highly flammable.

Properties of MIL-J-5624F, JP-5(1) (Petroleum Base Fluid)

	1	i			Method
iscometric Properties	1	1000 ~	1100 =		
Viscosity, centistokes, at:	55° ₽	100° F	150° F		ļ
O paig	1				
3,000 paig	1				See NSRDL
5,000 paig					Annapolis Repor
8,000 paig	1				MATLAB 350
10,000 paig	1				1 -
15,000 psig	1				-
20,000 psig	1				-
		:			
		<u>'</u>			
	1	i i			
,			1		Ĭ.
]
Viscosity, centistokes, at -50° F,	16.5 max				ASTM D-1445
O paig	2015			•	ASIR D-147
Viscosity Slope, ASTM	1				į.
abricating Ability	 				
4-Ball Wear Test, 30 min, 50° C,]		[Fed. Method 650
52100 steel, average scar dia.,	1				(modified)
mm:					(modified)
1 kg	1				1.
3 kg	1 1				1.
5 kg					1.
J my	į l				1 -
					}
errosion Protection	}				
Stirred Rust Test, 10% seawater,	Fail				ASTM D-665
140° F, 2 days	_				1
On-Off Rust Test, 50% seawater,	Fail				Sce Chapter 2
140° F, 30 days	1 !				Test C-5
Ambient Pressure, coupon) 1		ļ		See Chapter 2
stirred, corrosion test, weight	, !		ĺ		Test C-1
change, mg	1 [
Copper	, ,				1 -
Stainless Steel, 316					-
Copper-Nickel (70-30))				-
Aluminum, QQ-A-250-4b]				-
Phosphor-Bronze)	ļ			1 -
Steel, galvanized	ļ ļ				} -
Steel, 1009	[i		-
Aluminum, 29-A-250-11	} !				} -
Bronze	} 				-
Monel	, 1				! -
Silver Base Brazing Alloy	; ;		j		
20,000 PSIG Pressure-Cycled	! !				See Chapter 2
Corrosion Test (1% seawater),	[]	j			Test C-2
weight change, mg		1			
Insulated Specimens:))		j		
Copper	<u> </u>	i] -
Stainless Steel, 316]	l	İ		-
Copper-Nickel (70-30)	[]] -
Aluminum, QQ-A-250-4b			ļ		-
Phosphor-Bronze]	}	,		j -
Steel, galvanined]		j		-
Steel, 1009		[-
Aluminum, QQ-A-250-11	}	ļ	j] -
Bronze		ļ	Ì		} -
Monel	į]		-
Silver Base Brazing Alloy					t

					Method
Strongion Protection (Cont)	1	ı	1		Mathod
Blectrically Coupled Specimens	.1	l	l l	ł	1 - 1
Copper-Aluminum, QQ-A-250-11		I		1	
Aluminum QQ-A-250-4b -	' I	ì			1 _
Copper-Mickel (70-30)	l	1	1	ł	
Nonel-Bronse	1		1	1	1 -
Stainless Steel (516) -	ł	ł	1		1 -
Phosphor-Bronze	1			1	1
Silver Base Brasing Alloy -	i	1	1		1 -
Steel, 1004	1	1	i		i
Aluminum QQ-A-250-11 -	1	i e			1 _
Bronse	1	ì	i .		1
Aluminum QQ-A-250-4b -	1	İ			1 -
Steel, 1609	i i	į.			1
20,000 PSIG Stirred Corrosion	Í	1	1	1	See Chapter ?
Test, weight change, mg	Í	1	1	i	Test C-4
Insulated Specimens:	i .	1			
Copper	ſ	İ	[
Stainless Steel, 316		1	1	İ	l -
Copper-Nickel (70-30)	1	[1	[[-
Aluminum, QQ-A-250-4b	ĺ	1	1	1	i -
Phosphor-Bronse	ì		1		-
Steel, galvanised	[1	1		1 -
Steel, 1009	Ĭ	f	İ		l -
Aluminum, QQ-A-250-11	ļ	-	1		l -
Bronze	i	i	ĺ	[1 -
Mone 1	1	1	1	!	1 -
Silver Base Brazing Alloy	1	1	1	ļ	l -
Electrically Coupled Specimens:	:1	[[1	[
Copper-Aluminum, QQ-A-250-11	ı l	1	1	j	1 -
Aluminum, QQ-A-250-4b -	[1	1		1 -
Copper-Mickel (70-30)	Į.	1			
Monel-Bronze	J	ļ	1		J _
Stainless Steel (316) -	1		1		! -
Phosphor-Bronze	ì	1	i		l
Silver Base Brazing Alloy -	1	1	1		1 -
Steel, 1009	1	1	1		ĺ
Aluminum, QQ-A-250-11 -	f	İ	1	Í	! -
Bronze]	}	1]	
Aluminum, QQ-A-250-4b -	ł	l			-
Steel, 1009	ſ	[1		
Pump Test		Ì	ł	i	Proposed military
Average Weight Loss, mg	1	[1]	specification for
Steel Gears	ļ	j	1	j	sea-water emulsi-
Bronze Bushings		l	1		fying oils
Corrosion Coupons, weight loss,	[1			
each, mg/cm ²		1	ì		
Copper	į		ļ		-
Aluminum	1	ì	1		-
Steel, galvanized		1	J	j	-
Steel, 1009	1	ł		ĺ	-
Silver Base Brazing Alloy		1			-
ielectric Properties	}		}		ASTM D-1169 (mod-
Resistivity, 72 F. ohm-cm:	1.	1	i		ified). See Chap-
As-Received	4.0x10 ¹		ì	j .	ter 2. Test R-1
With Sea-Water Contamination:	1	J	1		See Chapter 2
0.1% by volume	1	1			Test E-5
0.5% by volume	,		1		-
2.0% by volume	į	ļ	1		-
With Carbon Contamination:	!	i			See Chapter 2
0.1≸ wt/vol.	j	j	1		Test E-6
0.25% wt/vol.]]	}		-
0 Eff /1	t .	,			

	1	1		Method
Dielectric Properties (Cont)	ŀ	1		1
After 50,000 Electric Ares	ļ	1 1		See Chapter 2
(makes and breaks) at 90		1 1		Test E-7
volts, 10 amperes, rests-		1		
tive load		1 1		
Not filtered		{		-
Filtered		l i		-
Solids generated, gram		1 1		i -
Dissipation Factor, 72° F. %		1 1		See Chapter ?
As-Received	1.3		1	Test E-2
With Sea-Water Contamination;		1 1		See Chapter 2
0.1% by volume		i i	j	Test C-5
0.5% by volume			i	-
2.0% by volume] [-
With Carbon Contamination:] [j	See Chapter 2
0.10% wt/vol.			{	Test E-6
0.25° wt/vol.			1	-
0.50% wt/vol.		i i	1	-
After 50,000 Electric Ares			ì	1
(makes and breaks) at 90]	1	1
volts, 10 amperes, resis-		1 [j	1
tive load]	j	1
Not filtered		1 1		-
Filtered		1		1 -
Solids generated, gram		1	1	-
Dielectric Breakdown Voltage,		l		ASTM D-877 (mod-
0.05-inch gap, 72° F, kv		!!	1	ified) See Chap-
As received	13.1	j i	ł	ter 2, Test E-3
With sea-water contamination:		1	. [See Chapter 2
0.15 by volume				Test E-5
0.5% by volume		1		 -
2.0% by volume		1	1	l -
With carbon contamination:		1	1	See Chapter 2
0.10% wt/vol.				Test E-6
0.255 wt/vol.		i I	į	1 _ 1000 2-0
0.50% wt/vol.		1	1	1 _
After 50,000 electric arcs				
(makes and breaks) at 90		1		
volts, 10 amperes, resis-		i		
tive load		!!		
Not filtered		1 [1_
Filtered		1		1 [
		1	-	I _
Solids generated, gram Contact Life, silver-cadmium, 10		į l	j	See Chapter 2
]		Test E-8
volts, 10 amperes, resistive load, 6000 psi, 65°-85° F		j	I	lest E-O
• • • • •		ļ i	1	1
Number of tests		l	ļ	-
Operations to failure (range)		ļ <u> </u>		1
Emulsion Stability		}	l	1 sems n 1/01
Paddle Test, after 1-hour set-]	I	ASTM D-1401
tling:		1 /	i	[
Oil, ml			1	1 -
Emulsion, ml			ļ	-
Water, ml			j	
Electric Probe Test, time for			ļ	See Chapter 2
water separation, min			ĺ	Test E-4
Material Compatibility Static 20KPSI			l	See Chapter 2
Butyl			İ	Test C-3
Buna N			ļ	-
Viton B			ł	1 -
Ethylene-Propylene		i i	I	-
		, ,		
Tetrafluoroethylene (Teflon)		¦	1	1 -
Tetrafluoroethylene (Teflon) Neoprene				-
- ' ' '				-
Neoprene				-

Volatility Density, grams/cubic centimeter, at: O psig 5,000 psig 5,000 psig 10,000 psig 15,000 psig 20,000 psig 1sothermal Compressibility, volume decrease, f, at: O psig 3,000 psig 10,000 psig 10,000 psig 10,000 psig 10,000 psig 10,000 psig 10,000 psig 10,000 psig Chemical Stability Oxidation Stability Test, 250° F Hydrolytic Stability Test Specimen appearance Fluid acid number increase, mg KOM/gram fluid Water acidity, mg KOH Insolubles, f Thermal Stability Test Fire Resistance Flash Point, °F Autogeneous Ignition Temperature, °F High-Pressure Spray Combustor Ninimum spontaneous ignition Prove F 100° F 100° F See NSRD Annapolis See NSRD Annapolis See NSRD Annapolis See NSRD Annapolis Annapolis See NSRD Annapolis Annapolis See NSRD Annapolis Annapolis Annapolis Annapolis Annapolis See NSRD Annapolis Annapolis Annapolis Annapolis See NSRD Annapolis Ann	L'eport
Density, yrams/cubic centimeter, at: Opsig	s keport
O psig 3,000 psig 5,000 psig 8,000 psig 10,000 psig 15,000 psig 20,000 psig 20,000 psig 3,000 psig 3,000 psig 10,000 psig 3,000 psig 10,000 psig 10,000 psig 10,000 psig 10,000 psig 10,000 psig 10,000 psig Chemical Stability Oxidation Stability Test, 203° F, hours to failure Oxidation Stability Test, 250° F Hydrolytic Stability Test Specimen change, mg Specimen appearance Fluid acid number increase, mg ROH/gram fluid Mater acidity, mg ROH Insolubles, % Thermal Stability Test Fire Resistance Flash Point, °F ASTM D-02 ASTM D-02 ASTM D-03 ASTM D-02 ASTM D-03 ASTM D-04 ASTM D-04 ASTM D-04 ASTM D-04 ASTM D-04 ASTM D-04 ASTM D-04 ASTM D-04 ASTM D-04 ASTM D-04 ASTM D-04 ASTM D-	s keport
3,000 psig 5,000 psig 10,000 psig 15,000 psig 15,000 psig 20,000 psig 1sothermal Compressibility, volume decrease, %, at:	s keport
5,000 psig 8,000 psig 10,000 psig 15,000 psig 15,000 psig 20,000 psig Isothermal Compressibility, volume decrease, \$\frac{1}{2}\$, at:	•
8,000 psig 10,000 psig 20,000 psig 20,000 psig lisothermal Compressibility, volume decrease, %, at: 0 psig 3,000 psig 3,000 psig 3,000 psig 10,000 psig 15,000 psig 20,000 psig 20,000 psig 20,000 psig 20,000 psig Chemical Stability Oxidation Stability Test, 203° F, hours to failure Oxidation Stability Test Specimen change, mg Specimen appearance Fluid acid number increase, mg NOH/gram fluid Water acidity, mg NOH Insolubles, % Thermal Stability Test Fire Resistance Flash Point, °F Autogeneous Ignition Temperature, °F High-Pressure Spray Combustor Ninimum spontaneous ignition See NSRD Annapolis	.O
10,000 psig 15,000 psig 20,000 psig Isothermal Compressibility, volume decrease, %, at: 0 psig 3,000 psig 3,000 psig 10,000 psig 15,000 psig 15,000 psig 15,000 psig 16,000 psig 16,000 psig 16,000 psig 16,000 psig 16,000 psig 16,000 psig 16,000 psig 16,000 psig 17,000 psig 18,000 psig 19,000 psig 10,000	
15,000 psig 20,000 psig 1sothermal Compressibility, volume decrease, % at: O psig 3,000 psig 3,000 psig 10,000 psig 10,000 psig 20,000 psig 20,000 psig 20,000 psig 20,000 psig 20,000 psig 20,000 psig Chemical Stability Oxidation Stability Test, 203° F, hours to failure Oxidation Stability Test, 250° F Hydrolytic Stability Test Specimen appearance Fluid acid number increase, mg MOH/gram fluid Mater acidity, mg MOH Insolubles, % Thermal Stability Test Fire Resistance Flash Point, °F Autogeneous Ignition Temperature, F High-Pressure Spray Combustor Ninimum spontaneous ignition 35° F 100° F 11,0° F See NSRD Annapolis ASTN D-0° AS	
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Isothermal Compressibility, Volume decrease, %, at: O psig 3,000 psig 3,000 psig 5,000 psig 15,000 psig 15,000 psig 15,000 psig 20,000 psig 20,000 psig Chemical Stability Oxidation Stability Test, 203° F, hours to failure Oxidation Stability Test, 250° F Hydrolytic Stability Test Specimen change, mg Specimen appearance Fluid acid number increase, mg KOH/gram fluid Water acidity, mg KOH Insolubles, % Thermal Stability Test Fire Resistance Flash Point, °F ASTN D-92 ASTN D-92 ASTN D-92 ASTN D-92 ASTN D-92 ASTN D-92 ASTN D-92 ASTN D-92 ASTN D-92 ASTN D-92 ASTN D-92 ASTN D-92 ASTN D-92 ASTN D-93 ASTN D-93 ASTN D-93 ASTN D-94 ASTN D-95	
decrease, %, at: O psig 3,000 psig 5,000 psig 10,000 psig 15,000 psig 20,000 psig 20,000 psig Chemical Stability Oxidation Stability Test, 203° F, hours to failure Oxidation Stability Test, 250° F Hydrolytic Stability Test Specimen change, mg Specimen change, mg Specimen appearance Fluid acid number increase, mg KOH/gram fluid Water acidity, mg KOH Insolubles, % Thermal Stability Test Fire Resistance Flash Point, °F Autogeneous Ignition Temperature, °F High-Pressure Spray Combustor Kinimum spontaneous ignition See NSRDI Annapolis ANTALAB 32 ASTN D-01 ASTN D-02 ASTN D-02 ASTN D-02 ASTN D-02 ASTN D-02 ASTN D-02 ASTN D-03 ASTN D-04	
O psig 3,000 psig 5,000 psig 10,000 psig 115,000 psig 10,000 psig 20,000 psig Chemical Stability Oxidation Stability Test, 203° F, hours to failure Oxidation Stability Test 250° F Hydrolytic Stability Test Specimen change, mg Specimen appearance Fluid acid number increase, mg NOH/gram fluid Water acidity, mg NOH Insolubles, % Thermal Stability Test Fire Resistance Flash Point, °F Autogeneous Ignition Temperature, F High-Pressure Spray Combustor Minimum spontaneous ignition Annapolis NATLAB 39 ASTN D-04 ASTN D-04 ASTN D-07 ASTN D-0	_
3,000 psig 5,000 psig 3,000 psig 10,000 psig 15,000 psig 20,000 psig 20,000 psig Chemical Stability Oxidation Stability Test, 203° F, hours to failure Oxidation Stability Test, 250° F Hydrolytic Stability Test Specimen change, mg Specimen appearance Fluid acid number increase, mg MOH/gram fluid Water acidity, mg MOH Insolubles, \$ Thermal Stability Test Fire Resistance Flash Point, °F Fire Point, °F Autogeneous Ignition Temperature, °F High-Pressure Spray Combustor Minimum spontaneous ignition NATIAB 32 ASTN D-04 ASTN D-04 ASTN D-02 ASTN D-02 ASTN D-02 ASTN D-02 ASTN D-02 ASTN D-03 ASTN D-03 ASTN D-03 ASTN D-03 ASTN D-03 ASTN D-03 ASTN D-03 ASTN D-03 ASTN D-04 ASTN D-05 ASTN D-05 ASTN D-06 ASTN D-07 ASTN D	
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Chemical Stability Oxidation Stability Test, 203° F, hours to failure Oxidation Stability Test, 250° F Hydrolytic Stability Test Specimen change, mg Specimen appearance Fluid acid number increase, mg NOH/gram fluid Water acidity, mg NOH Insolubles, \$ Thermal Stability Test Fire Resistance Flash Point, °F Autogeneous Ignition Temperature, °F High-Pressure Spray Combustor Minimum spontaneous ignition ASTM D-72 ASTM D-71 Sec NEL R 51/66 of	
Oxidation Stability Test, 203° F, hours to failure Oxidation Stability Test, 250° F Hydrolytic Stability Test Specimen change, mg Specimen appearance Fluid acid number increase, mg KOH/gram fluid Water acidity, mg KOH Insolubles, \$\mathscr{E}\$ Thermal Stability Test Fire Resistance Flash Point, °F Autogeneous Ignition Temperature, °F High-Pressure Spray Combustor Minimum spontaneous ignition ASTN D-71 Sec NEL F 51/66 of	**********
Oxidation Stability Test, 250° F Hydrolytic Stability Test Specimen change, mg Specimen appearance Fluid acid number increase, mg KOH/gram fluid Water acidity, mg KOH Insolubles, \$ Thermal Stability Test Fire Resistance Flash Point, °F Autogeneous Ignition Temperature, °F High-Pressure Spray Combustor Minimum spontaneous ignition Fedd. Metl Military cation Milita	•
Hydrolytic Stability Test Specimen change, mg Specimen appearance Fluid acid number increase, mg NOH/gram fluid Water acidity, mg NOH Insolubles, \$ Thermal Stability Test Fire Resistance Flash Point, *F Autogeneous Ignition Temperature, *F High-Pressure Spray Combustor Minimum spontaneous ignition Military cation	
Specimen change, mg Specimen appearance Fluid acid number increase, mg KOH/gram fluid Water acidity, mg KOH Insolubles, \$\frac{F}{Intermal Stability Test}}\$ Fire Resistance Flash Point, "F Autogeneous Ignition Temperature, "F High-Pressure Spray Combustor Minimum spontaneous ignition Cation K1 1945/7B	.a.a 5308
Specimen appearance Fluid acid number increase, mg KOH/gram fluid Water acidity, mg KOH Insolubles, \$\frac{F}{2}\$ Thermal Stability Test Fire Resistance Flash Point, "F Autogeneous Ignition Temperature, F High-Pressure Spray Combustor Ninimum spontaneous ignition 1945/7B	speciti-
Fluid acid number increase, mg NOH/gram fluid Water acidity, mg NOH Insolubles, \$\% Thermal Stability Test Fire Resistance Flash Point, "F Fire Point, "F Autogeneous Ignition Temperature, "F High-Pressure Spray Combustor Ninimum spontaneous ignition	L-11-
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Water acidity, mg NOH Insolubles, \$\% Thermal Stability Test Fire Resistance Flash Point, *F Autogeneous Ignition Temperature, *F High-Pressure Spray Combustor Ninimum spontaneous ignition ASTM D-72 ASTM	
Insolubles, % Thermal Stability Test Fire Resistance Flash Point, °F Fire Point, °F Autogeneous Ignition Temperature, °F High-Pressure Spray Combustor Minimum spontaneous ignition 140 min ASTM D-72 ASTM D-92 ASTM D-71 Sec NEL R 51/66 of	
Thermal Stability Test Fire Resistance Flash Point, °F Astm D=92 Astm D=92 Astm D=92 Astm D=71 Astm D=72 Astm D=71 Astm D=72 Astm D=71 Astm D=72 Astm D=71 Astm D=72 Astm D=72 Astm D=72 Astm D=72 Astm D=72 Astm D=72 Astm D=72 Astm D=72	
Fire Resistance Flash Point, P Fire Point, P Autogeneous Ignition Temperature, P High-Pressure Spray Combustor Ninimum spontaneous ignition 140 min ASTM D-92 ASTM D-71 ASTM D-71 ASTM D-71 ASTM D-71 ASTM D-71 ASTM D-71 ASTM D-71 ASTM D-71 ASTM D-71 ASTM D-71 ASTM D-71 ASTM D-72 ASTM D-71 ASTM D-72 ASTM D-72 ASTM D-71 ASTM D-72 ASTM D	
Flash Point, °F Pire Point, °F Autogeneous Ignition Temperature, °F High-Pressure Spray Combustor Ninimum spontaneous ignition 140 min ASTM D-72 ASTM D-71 ASTM D-71 ASTM D-71 ASTM D-71 ASTM D-72 ASTM D-72 ASTM D-71 ASTM D-72 ASTM D-72 ASTM D-72 ASTM D-72 ASTM D-72 ASTM D-72 ASTM D-72	
Fire Point, °F Autogeneous Ignition Temperature, °F High-Pressure Spray Combustor Ninimum spontaneous ignition ASTM D-92 ASTM D-71 See NEL F 51/66 of	
Autogeneous Ignition Temperature, F High-Pressure Spray Combustor Rinimum spontaneous ignition ASTM D-71 See NEL R 51/66 of	
High-Pressure Spray Combustor Rinimum spontaneous ignition Sec NEL F 51/66 of	
Ninimum spontaneous ignition 51/66 of	55
	cport
	March
temperature, °F 1967	
Minimum reaction temperature,	
*F	
No indication of fire, °F	
Maximum pressure change, psi	
Lowest temperature of maximum	
pressure change, °F	
Temperature range explored, °F	
Miscellaneous Properties Pour Point, F ASTM D=97	
Foaming Tendency, 75° F Foam after 5-minute aeration,	2
ml Time out, minutes	
Foam after 10-minute settling,	
ml	
Nater Content, 5 by Weight Neutrality, qualitative ASTM D-17 Fed. Meth	
Contamination	בטוק בי
Number and size of particles and SAE Mothor	l app.
fibers in 100-ml fluid 598	- W// -
25-100 micrometers	
100-500 micrometers	
over 500 micrometers	
particles over 250 microm-	
eters except fibers (length	
ten times diameter)	
Specific Gravity, 60/60° F 0.79-0.85	1 ARP_79 6
Color ASTH D-150	ARP-785
Cost, \$/gal available from supplier -	
Availability Govt sped	

MIL-L-6081C, Grade 1010

Suggested Uses and Possible Limitations

The fluid covered by MIL-L-608lC is a low-viscosity, petroleum-base fluid originally developed as a jet engine lubricating oil. The data given here were collected on the 1010 grade. The lubricating, electrical, and chemical properties of MIL-L-608lC indicate that it may be used as a general purpose fluid for depths down to 8000 feet. All of its properties deteriorate rapidly when it becomes contaminated with seawater. Its corrosion inhibiting properties are so poor that ball bearings in moving machinery rusted in MIL-L-608lC contaminated with seawater. Its flammability properties are marginal. While its initial dielectric properties are good, it shows a rapid drop in dielectric breakdown voltage with sea-water contamination. This makes it a questionable choice for any electrical application.

Properties of MIL-L-6081C (1)

	(Petroleum	Base Flu	id)		
					Method
Viscometric Properties] _]			Ì	
Viscosity, centistokes, at:	35° F	100° F	150° F		
0 berd	53.73	10.08	5.85		j
3,000 paig	93.56	15.43	6.50		See NSRDI
5,000 pmig	139.7	19.77	7.81		Annapolis Reput
8,000 pelg	228.5	28.98	11.15		MATLES 555
10,000 paig	323.6	37.37	13.35		-
15,000 paig	778.6	59.84	21.98		-
20,000 paig	1834	129.9	36.23	Ì] -
	1 1				
	i j				
	1				1
	1				1
	1 1			,	1
	1				
	1 1				
Viscosity, contistokes, at 210° F.	1 1				3000 0 444
O paig	2.51				ASTM D-445
	الحدة م				
Viscosity Slope, ASTM Lubricating Ability	0.83				↓
4-Ball Wear Test, 30 min, 50° C.	1 1				Ped. Method 6503
52100 steel, average scar dis.	1	ì			(modified)
ma: 1 kg		l			(modified)
3 kg					
5 kg	0.43	ľ			! -
15 kg	0.70				-
Rolling Contact Patigue Test, hr:]				1 -
Blo life: Dry	33.5				
With 1≸ synthetic semmeter	15.3				1
850 life: bry	135.4	ı			
	28.7	ļ			
With 1% synthetic	1 20.1				ł
Corrosion Protection					!
Stirred Rust Test, 10% seawater,	Fail	į			ASTH 0-665
140° F, 2 days	Fall				ASIA Daddy
On-Off Rust Test, 50% seawater,	Pail				See Chapter ?
140° P, 30 days	7411	İ			Test C-5
Ambient Pressure, coupon	1 1				See Chapter ?
stirred, corrosion test, weight	1 1				Test C-1
change, mg	1 1	1			1
Copper	42.6	i	1		1 .
Stainless Steel, 316	+ 1.0	1	}		
Copper-Nickel (70-30)	- 0.1	1			
Aluminum, QQ-A-250-4b	+185.2(2)		ļ		_
Phosphor-Bronze	-54.2		į		1.
Steel, galvanized	-661.4				İ -
Steel, 1009	-74.7		aceleran		-
Aluminum, 00-A-250-11	-60.5		l		1 -
Bronze	-34.2	}	Į		1.
Monel	+ 0.4	ŀ	1		1 -
Silver Base Brazing Alloy	-5.4(2)	!			
20,000 PSIG Pressure-Cycled	-9.41	1	ļ		See Chapter ?
Corrosion Test (1% seawater),		ĺ	İ		Test C-2
weight change, mg	1				
Insulated Specimens:	1	I	ļ		
Copper	1	Î	į		
Stainless Steel, 316	1 1	al la company			_
Copper-Mickel (70-30)	1	Į	ļ		
Aluminum, QQ-A-250-4b	1	ĺ			_
Aluminum, yg -A-cycl>40 Phosphor-Bronse		I			
<pre>snompnor-mronse \$teel, galvanized</pre>	1	ļ			"
• •	!	1	ĺ		-
Stee), 1009	!	1			-
Aluminum, 00-A-250-11		į			-
Bronze	1	į	1		-
Mone 1	j i	i	İ		-
Silve: Rase Brazing Alloy	<u>ا</u>				¥

	T	T	T	<u> </u>	Method
Corresion Protection (Cont)	· I	1			
Electrically Coupled Specimens	.1	i	1		_
Copper-Aluminum, UV-A-250-1		ļ	1	1	1 -
Aliminum QQ-A-250-Ab -	1	1	1		-
Copper-Mickel (70-50)	1				
None i -Bronse	1	j]]] -
Stainless Steel (516) -	j .	l	1	j	1 -
Phosphor-Bronze	ł	1	1	Ì	
Silver Base Brasing Alloy -	1	1	f	f	
Steel, 1004	1	1	1	ł	1
Aluminum QQ-A-250-11 -		ĺ			1 -
Bronse		}			
Aluminum QQ-A-250-46 -					1 -
\$teel, 1009	1	i			1
20,000 PSIG Stirred Corresion			1		See Chapter ?
Test, weight change, mg	i	1	1		Tost C-4
Insulated Specimens:	1	1	1		
Copper	1	i			! .
Bruinless Steel, 316	1	1]		1.
Couper-Mickel (70-30)	1	1	[1 -
Aluminum, QQ-A-250-4b	1	ŀ	1		
Phos. hor-Bronze	1	1	!		1 _
Steel, galvenized	1	1	1		1 -
Steel, 1009	1	1			_
Atuminum, QQ-A-250-11		1	1		_
Bronze		1			_
None 1	1	1			1 _
Silver Base Brazing Alloy		ļ			l <u>.</u>
Electrically Coupled Specimens	.	ĺ	1 1		1
Copper-Aluminum, QQ-A-750-1	1]		_
Aluminum, QQ-A-250-4b -	Ì	1			_
Copper-Rickel (70-30)		ĺ			
Monel-Bronze	1	ļ	1		_
Stainless Steel (516) -	[_
Phosphor-Bronze		İ			
Silver Base Brazing Allo -	1	1			_
Steel, 1009	1		1		
Aluminum, QQ-A-2,0-11 -	1				
Bronze	i				
Aluminum, GQ-A-250-4b -	1				_
Steel, 1009	[[
Pump Test	1	1			Proposed military
Average Weight Loss, mg		1	1		specification for
Steel Gears	298	Į.	l i		sea-watr. emuls:-
Bronze Bushing	31		1		fying oils
Corrosion Coupons, weight loss		1]]		-
each, ag/cm²	1				•
Coppe r	0	1	1		-
Aluminum	1 0	1			-
Steel, galvanized	3.2	1	j í		-
Steel, 1009	1.4				-
Silver Base Brazing Alloy	0.32		1		÷
ielectric Properties		!]		ASTM D-1169 (mod-
Besistivity, 78 F, ohs-ch:	1				if.ed), See Chap-
Ac-Received (3)	6.4x1012	}	1		ter Test E-1
With Sea-Water Contamination:	9. 1012]	, ,		See Chapter 2
	1	ļ	į l		Test E-5
55 by volume		Ī]		•
2.0€ by volume	1		Ì		-
With Carbon Contamination:	i		-		See Chapter ?
0.1% wt/vol.				•	Test E-6
0.25% wt/vol.	1				-

O

Dialectric Properties (Cont)		Me thod
After 50,000 Electric Arcs	1 1	See Chapte: 2
(makes and breaks) at 90		Test 2-7
Molts, 19 amperes, resis-		148(5-1
tive load		}
Not filtered	2.0×1012	
Filtered	1.9=1012	-
Solida generated, gram	0.70	1 1-
Dissipation Factor, 78° F. #		See Chapter ?
As-Received (3) 1.0	Test E-2
With Sea-Water Contamination	7 3.7	See Chapter ?
Orize by Actions	1 1 1	Test E-5
0.5≸ by volume	i i	•
2.0% by volume With Carbon Contamination:	1 1	1
0.10% wt/vol.		See Chapter 2
0.25% wt/vol.		Test 2-6
0.50∜ wt/vol.		
After 50,000 Electric Arcs		- · · · · · · · · · · · · · · · · · ·
(makes and breaks) at 90		
volts, 10 amperes, resis-		
tive load		
Not filtered	0.3	-
Filtered	1.6	-
Solids generated, gram] -	-
Dielectric Breakdown Voltage,		ASTN D-877 (mod-
0.05-inch gap, 78° F, kv		ified). See Chap
As received (3)	20.5	ter 2. Test E-5
With sea-water contamination?	<5.0	See Chapter 2
		Test E-5
0.5≸ by volume		-
2.0≸ by volume		-
With carbon contamination: 0.10≸ wt/vol.		See Chapter 2
0.25≸ wt/vol.		Test E-6
0.50% wt/vol.		-
After 50,000 electric arcs		-
(makes and breaks) at 90		
volts, 10 amperes, resis-		
tive load		
Not filtered	17.6	
Filtered	22.8	_
Solids generated, gram	1	_
Contact Life, silver-cadmium, 50		See Chapter 2
volts, 10 amperes, resistive		Test E-8
load, 6000 psi, 65°-85° F		
Number of tests		-
Operations to failure (tur)		
ulsion Stability		
Paddle Test, after 1-hour set-		ASTM D-1401
tlings		
Oil, ml	40	-
Emulsion, ml		-
Water, ml	40	- Charles 5
Electric Probe Test, time for	1.5	See Chapter ?
water separation, min		Test E-4
ternal Compatibility Static 20KPSF Sutvl	Poor	See Chapter C
Buna N	Good	700 C-3
Viton B	Good Good	_
Sthylene-Propylene	Poor	-
Tetrafluoroethylene (Teflon)	Good	i
Heaptens	Fair	
Thiokel	-	
Silicone	Tair	
Fluorosilicona	Fair	1

	T	r			Method
Volatility	•				•
Toxicity	Petroleum				
Density, grams/cubic centimeter, at:	35	100 F	150° F		
O paig	0.8815	0.8567	0.9380		See NSRDL
3,000 psig	0.8905	0.8671	0.8501		Annapolia Report
5,000 psig	0.8959	0.8740	0.8576		NATLAB 550
8,000 pmig	0.9041	0.8831	0.8677		ì
10,000 pmig	0.9092	0.8884	0.8738		
15,000 psig	0.9200	0.9303	0.8871		
20,000 psig	0.9304	0.9112	0.8992 150 F		
Isothermal Compressibility, volume	35° F	90° F	150 5		See NSRDL
decrease, 5, at:	j				Annapolis Report
O paig	1.04	1.18	1.42		NATLAB 350
3,000 paig	1.64	1.91	2.29		
5,000 paig	2.54	2.91	3.42		
8,000 paig		3.48	4.10		1
10,000 paig	3.08	1 7			
15,000 paig	4.22	4.73 5.86	5.53 6.80	•	į.
20,000 paid	5.29	2.00	0.00		
Chemical Stability Oxidation Stability Test, 203° F,	1		1		ASTN D-943
		Ì	i		1
hours to failure Oxidation Stability Test, 250° F					Fed. Method 5308
Hydrolytic Stability Test	ļ	İ			Military specifi-
Specimen change, mg	İ	l			cation NIL-H-
Specimen change, my Specimen appearance	1		1	ĺ	19457B
Fluid acid number increase,					
mq NOH/qram fluid	1		1		
Water acidity, mg KOH			1		_
Insolubles, \$!			 -
Thermal Stability Test		ĺ	j		_
Fire Resistance			1		Ļ
Flash Point, °F	305		1		ASTM D-92
Fire Point, F	335		į.	l	ASTM D-92
Autogeneous Ignition Temperature, 1	י עני	İ	i	}	ASTM D-2155
High-Pressure Spray Combustor			1	ļ	See MEL Report
Minimum spontaneous ignition	1	l	1	Ĭ	31/66 of March
temperature, F			1		1967
Minimum reaction temperature,	1		i		-
*p			1		
No indication of fire, "F	1	ļ	1		-
Maximum pressure change, psi		ŀ			1 -
Lowest temperature of maximum	1	ļ	1		-
pressure change, F		İ	1		ì
Temperature range explored, *F	1	1	İ		-
Miscellaneous Properties	1	İ	1		
Pour Point, F	<-70	İ	1		ASTH D-97
Foaming Tendency, 75° F		l		1	astm d-892
Foam after 5-minute aeration,		i			-
mi	45	1			
Time out, minutes	1	1	1		-
Foam after 10-minute settling,	1		1		-
ml	1	1			
Neutralization Number, mg KOH/gram	0.05				ASTM D-974
Water Content, % by wight	0.004	1	ì	ł	ASTM D-1744
Neutrality, qualitative	1	!			Fed. Method 5101
Contamination	1	1	1	1	1
Number and size of particles an	a	1		1	SAE Method ARP-
fibers in 100-ml fluid	1	1	l	1	598
25-100 micrometers	1	1	1		1 -
100-500 micrometers	1	1	1	1	1 -
over 500 micrometers	1	1	1		-
particles over 250 microm-	ļ	1		ĺ	-
eters except fibers (length	1	1			
ten times diameter)	1	1	1	1	030 Wakk-4 500 -
Gravimetric Value, mg/100 ml		1	1	1	SAE Method ARP-78
Specific gravity at 60/60° F	0.89	1		1	ASTM-D-1298
Color	40	1	1	1	ASTM D-1500
Cost \$/gal	\$0.75	_	j		1 -
Availability	Gov. spe	C3.	t		

Determinations made at atmospheric pressure, unless noted. Saturated with seawater.

Heavy deposits: indicates corrosion not show by weight change. Races and balls severely rusted. Entire oil circulating system clogged with

Supplementary Properties of MIL-L-6081C(1)
(Petroleum Base Fluid)

		Method
Material Comparibility with	Poor	See Chapter II
Materal Rubber	Poor Good	1446 6.7
Polyurethene	9004	
<u> </u>		

^{*}Based on atmospheric pressure data.

MXL_H_6083C

Suggested Uses and Possible Limitations

The fluid covered by Military Specification MIL-H-6083C is a low-viscosity, petroleum-base fluid which was developed as an aircraft and missile hydraulic system preservative. It has the same viscometric properties as MIL-H-5606B fluids, but was not intended as a working system fluid and lubricant. The properties of MIL-H-6083C indicate that it can be used for all mechanical purposes at depths to 20,000 feet with good corrosion protection and sea-water emulsifying abilities. Its lubricating ability is marginal and it is highly flammable. Low electrical resistivity and high dissipation factor make it a questionable choice for any electrical application.

Properties of MIL-H-6083c(1) (Petroleum Base Fluid)

	(sectored				
Viscometric Properties]			Method
Viscosity, high shear, cs, at:	35° P	100° F	150° F		
O paig	30.25				
3,000 paig	43.35	11.78 15.66	7.27		Can NEBRI
5,000 paig	55.28	18.64	9.24		See NSRDL
8,000 paig			10.75		Annapolis Report
10,000 paig	77.65	24.30	13.45		MATLAB 350
	101.6	28.59	14.02		-
15,000 paig	173.9	42.57	21.99		-
20,000 psig	311.7	63.64	30.50		
Viscosity, low shear, cs, at:	35° 8	100° F	210 1		1
O paig	49.00	15.80	9.40		
3,000 paig	74.17	21.42	11.92		
5,000 paig	92.71	26.05	14.62		
8,000 paig	136.8	33.94	18.92		ļ
10,000 paig	175.3	39.51	22.13		
15,000 paig	325.6	61.13	33.53		
20,000 peig	591.2	93.77	48.27		1.5
Viscosity, centistokes, at 210° F,					ASTM 0-445
0 paig	4.39]			
Viscosity Slope, ASTN	0.484				
Lubricating Ability	1	ļ			1
4-Ball Wear Test, 30 min, 50° C,	1	}			Fed. Method 6503
52100 steel, average scar dia.,					(modified)
nom: 1 kg	0.12				1
3 kg	0.15	!			-
5 kg	0.16				1 -
Rolling Contact Fatigue Test, hr:	1				-
BlO life: Dry	20.0				
With 1% synthetic	14.5				
seawater]			
B50 life: Dry	50.6)			
With 1% synthetic	22.0				
seawater(3)					
Corrosion Protection	}				
Stirred Rust Test, 10% seawater,	Pass				ASTM D-865
140° F, 2 days	1				
On-Off Rust Test, 50% seawater,	Pass				See_Chapter 2
140° F, 30 days					Test C-5
Ambient Pressure, coupon	1				See_Chapter 2
stirred, corrosion test, weight	į				Test C+1
change, mg					1
Copper	-20.5				-
Stainless Steel, 316	- 0.1				1 -
Copper-Nickel (70-30)	- 4.6				-
Aluminum, QQ-A-250-4b	- 1.1				-
Phosphor-Bronze	-15.4				"
Steel, galvanized	-11.4				1 -
Steel, 1009	+ 0.3				-
Aluminum, QQ-A-250-11	+ 0.3				-
Bronse	- 8.4				-
Monel	0				-
wilver Base Brazing Alloy	- 7.1		i		0
20,000 PSIG Pressure-Cycled	[See Chapter 2
Corrosion Test (1% seawater),]				Test C-2
weight change, mg					1
Insulated Specimens:					
Copper	- 6.8	1			-
Stainless Steel, 316	0		İ		-
Copper-Mickel (70-30)	- 0.4		į		1 -
Aluminum, 99-A-250-4b	- 0.1				-
Phosphor-Bronze	- 0.8	1			-
Steel, galvanized	- 0.1	j)		j -
steel, 1009	- 0.2				-
Aluminum, QQ-A-250-11	-0.1				-
Bronze	j - 1.0				-
Mone1	- 0.2				-
Silver Base Brazing Alloy	1 - 0.3			<u></u>	ļ -

	T				Marked
orrosion Protection (Cont)	1			1	Method
Electrically Coupled Specimens:	1				1.
Copper-Aluminum, QQ-A-250-11		-0.1	j		
Aluminum QQ-A-250-4b -	- 0.2	-0.5	1		1 -
Copper-Nickel (70-30)	\	1 -0.5		1	-
Monel-Bronze	- 0.2	-0.5	1	ì	
Stainless Steel (516) -	0.2	-0.6		ì	
Phosphor-Bronze	1	1 -0.0	1	İ	"
Silver Base Brazing Alloy -	- 0.3	-0.1	i		
Steel, 1004	1 4.7	-0.1			1 -
Aluminum QQ-A-250-11 -	- 0.1	-0.8	1		f .
Bronze	" "	-0.6			-
Aluminum QQ-A-250-4b	- 0.1	١٥	Ì	1	
Steel, 1009	0.1	"		}	_
20,000 PSIG Stirred Corregion	(10% sea	l	1		0 0
Test, weight change, mg	(10) 500	Date:	}		See Chapter ? Test C-4
Insulated Specimens:	i	ł			1886 0.24
Copper	1	1	1		
Stainless Steel, 316	- 0.1		İ	•	1 -
Copper-Nickel (70-30)	- 0.2	ł	1	1	} ~
Aluminum, QQ-A-250-4b	- 0.3		1		ļ -
Phosphor-Bronze	+ 0.1		ł	ł	1 -
Steel, galvanized	- 0.6				-
Steel, 1009	- 0.7		1	1	-
Aluminum, QQ-A-250-11	- 0.6				-
Bronze	- 0.7] ~
Monel	- 0.4		1	l	1 -
Silver Base Brazing Alloy	- 0.6				-
Electrically Coupled Specimens:	- 0.6		1		-
Copper-Aluminum, UQ-A-250-11	1		-		i
Aluminum, QQ-A-250-4b -	,		ł	1	-
Copper-Nickel (70-30)	-0.2 -0.3				~
Monel-Bronze					
Stainless Steel (316) -	+0.2 0		1		-
Phosphor-Bronze	-0.2 -0.3				-
Silver Base Brazing Alloy -			1		}
Steel, 1009	+0.1 -0.1				-
Aluminum, 99-A-250-11 -			1		
Bronze	+0.2 +0.9				-
Aluminum, QQ-A-250-4b -	ام ما				
Steel, 1009	+0.2 +0.8				-
Pump Test					
Average Weight Loss, mg	1				Proposed military
Steel Gears	_				specification for sea-water emulsi-
Bronze Busnings	3				
Corrosion Coupons, weight loss,	3				fying oils
each, mg/cm ²	1]		
Copper	1		1		
Aluminum	İ				-
Steel, galvanized			}		-
Steel, 1009					-
Silver Base Brazing Alloy					-
electric Properties			1 1		-
Resistivity, 7% F, ohm-cm:					ASTM D-1169 (mod-
Az-Received	10		[ified). See Chap-
With Sea-Water Contamination:	4.0x10 ¹⁰		[ter 2. Test E-1
0.1% by volume	-				See Chapter 2
			Į į		Test E-5
0.5% by volume	1]		-
2.0% by volume					-
With Carbon Contamination: 0.1% wt/vol.					See Chapter 2
0.1% wt/vol.				i	Test E-6
0.20% Wt/vol. 0.5% Wt/vol.	ļ				•
U. DW WL/VUL.	1		ı i		_

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manta a la la la la la la la la la la la la	1	1 1 1	Method
Dielectric Properties (Cont)	ŀ	1	
After 50,000 Electric Arcs	1	1 1 1	See Chapter 2
(makes and breaks) at 90	1]]]	Test 2-7
volts, 10 amperes, resis-	j)	j
tive load	1 10	!	į.
Not filtered	2.0=1010]]	1 -
Filtered	2.041010		-
Solids generated, gram	1.00		_
Dissipation Factor, 740 y g	1	1 1 1	See Chapter 2
As-Received	6.1	! !	Test E-2
With Sea-Water Contamination:	1 313	[[See Chapter 2
	1	1 1	Test E-5
C.5% by volume(2)		1 1	1000 2-3
2.0% by volume(2)	i		[~
With Carbon Contamination:	l	}	See Chapter 2
0.10% wt/vol.	1	1 1	Test E-6
%25% wt/vol.	i	1 1	Test E-0
0.50% wt/vol.	1	1 1 1	· -
- · · · · ·	1	1 1 1	ļ -
After 50,000 Electric Arcs	1	1 t l	
(makes and breaks) at 90	1	1 1	į
volts, 10 amperes, resis-	1]]	į,
tive load	ı		į
Not filtered	10.2	1 1) -
Filtered	10.7		ļ -
Solids generated, gram		i [-
Dielectric Breakdown Voltage,	1	i (ASTM D-877 (mod-
0.05-inch gap, 74° F, kv	1		ified). See Chap
As received	25.5		ter 2. Test E-5
With sea-water contamination:	1 57.7		See Chapter 2
0.1% by volume			Test 2-5
0.5% by volume	i		1000 200
2.0% by volume	1		
With carbon contamination:	1		g = 0 = = 0
0.10% wt/vol.	ĺ		See Chapter 2
0.25% wt/vol.			Test E-6
0.50% wt/vol.	1		\ -
			i -
After 50,000 electric arcs	}		ŧ
(makes and breaks) at 90	}	}	j
volts, 10 amperes, resis-			•
tive load			ļ
Not filtered	14.0		-
Fil tered	26.5		ļ <u>-</u>
		1	-
Contact Life, silver-cadmium, 50		<u> </u>	See Chapter 2
volts, 10 amperes, resistive		1	Test E-8
load, 6000 psi, 65°-85° F	l		
Number of tests	2		1 -
Operations to Easilure (range)	72-404	l i	ļ
Emulsion Stability	12-404	l l	İ
Paddle Test, after 1-hour set-	1	1	ASTM D-1401
tlings			ASIA 5-1401
Oil, ml	1	1 1	İ
The state of the s	40	1 1	-
Emulsion, ml	1		-
Water, ml	39	1	-
Electric Probe Test, time for	20	1	See Chapter ?
water separation, min	1		Test E-4
Caterial Compatibility Static 20KPSI*			See Chapter 2
Butyl	Poor	1	Test C-3
Buna H	Pair-Good		-
Viton B	Good		-
Ethylene-Propylene	Poor		1 -
Tetraflucroethylene (Teflon)	Good	1	
Reoprene	Pair	1	_
Thickel			1 _
Silicone	Poor	1 1) <u> </u>
	1 1		i -
Pluorosilicone	Poor	i 1 i	t -

	T	T	7	T	Method
Volatility	Į			j	
Toxicity	Petroleum	ţ	į	{	1
Density, grams/cubic centimeter, at:	35° F	100 F	150° F		
0 paig	0.8698	0.8445	0.8253	1	See NSRDL
3,000 paig	0.8795	0.8560	0.8388	į.	Annapolis Report
5,000 psig	0.8859	0.8630	0.8472	j	NATLAB 550
8,000 paig	0.8948	0.8729	0.8573		1
10,000 paig	0.9003	0.8786	0.8680	ĺ	}
15,000 pmig	0.9122	0.8915	0.8773]
20,000 psiq	0.9234	0.9029	0.8898	}	1
Isothermal Compressibility, volume	35° F	90° F	150° P		
decrease, %, at:				1	See NSKDL
0 bard	1		Ì		Annapolis Report
3,000 paig	1.10	1.29	1.62		MATLAB 5',0
5,000 psig	1.82	2.08	2.58)	1
{ 8,000 p∗ig	2.79	3.17	3.74	•	
10,000 psig	3.39	3.79	4.93	1	ł
15,000 paig	4.65	5.15	5.93	1	
20,000 psig	5.81	6.33	7.24	1.	
Chemical Stability			·		
Oxidation Stability Test, 203° P,]	i	1	1	ASTM 0-943
hours to failure	1		1	1	
Oxidation Stability Test, 250° F) 1)	Fed. Method 530H
Hydrolytic Stability Test	! !			}	Military specifi-
Specimen change, mg	[]			}	cation MIL-H-
Specimen appearance	j 1			1	19457B
Fluid acid number increase,	1 1				1 -
mg KOH/gram fluid	}			1	1
Water acidity, mg NOH	1			į	ł -
Insolubles, #	1 1			[1 -
Thermal Stability Test	1 (l _
Fire Resistance	}				}
Flash Point, "P	230				ASTM D-92
Fire Point, *P	235				ASTM D-92
Autogeneous Ignition Temperature, °F	1				ASTM D-2155
High-Pressure Spray Combustor	1				See MEL Report
Minimum spontaneous ignition]	į			31/66 of March
temperature, "F	i j				1967
Minimum reaction temperature,	1 1	į	'		1 -
*F	1		5		}
No indication of fire, "F	!	(-
Maximum pressure change, psi	}	j			} _
Lowest temperature of maximum	1	ſ	j		-
pressure change, °F	1 (ļ	į		
Temperature range explored, °F	}	ì	j		-
Miscellaneous Properties	{		1		
Pour Point, P	<-75	}	1		A5TM D-97
Foaming Tendency, 75° F	45	}	}		ASTM D-892
Poam after 5-minute aeration,			}		-
ml -	1	į)		
Time out, minutes	1	1	ł		-
Foam after 10-minute settling,	}		ĺ		i -
ml	-	1	ļ		
Neutralization Number, mg KOH/gram	! !	1	i		ASTH D-374
Water Content, % by weight	0.043	}	į		ASTH D-1744
Neutrality, qualitative	}	1	ļ		Fed. Method 5101
Contamination	1		•		-
Number and size of particles and	{	1	}		SAE Method ARP-
fibers in 100-ml fluid		Ì	Ì		598
25-100 micrometers	1	ł	1		-
100-500 micrometers	1	([! - {
over 500 micrometers		j	į	Į.	-
particles over 250 microm-	. (ļ	i .	ł	-
eters except fibers (length	1	į	, respectively.	ì	
ten times diameter)	}	1	ł		į į
Gravimetric Value, mg/100 ml		Į	1	(SAF Method ARP-785
Specific gravity at 60/60° F	0.87		ļ	į	ASTN D-1298
Color	I	1	1	{	ASTM D-1300
Cost \$/gal Availability	2.00	1		į	-
	iov. epeci		I	i	_ 1

Determinations made at atmospheric pressure, unless noted. Saturated with seawater. No rust observed,

Supplementary Proportion of MIL-H-6083c(1)

Material Compatibility with		Method See Chapter 2
Meturel Rubber	Foor	Test C-3
Princ 8	Poor	

MIL-H-6083c fluid at 1000 psi, 230 ml of gas (measured at atmospheric pressure and 77° F) was produced by 115,000 arcs, with no arc suppression, at 50-volt open-circuit voltage and 5-ampere closed-circuit current on the contacts,

^{*}Based on atmospheric pressure data.

MIL-L-6085A

Suggested Uses and Possible Limitations

١.,

The fluid covered by MIL-L-6085A is a synthetic-base material usually consisting mainly of esters of dibasic organic acids. It has a low volatility and was developed for use as an aircraft instrument lubricating oil. The atmospheric pressure viscosity of MIL-L-6085A would lead to the prediction that it might be a satisfactory general-purpose fluid down to depths of 8000 feet. However, this fluid provides some limited corrosion protection. It is hydrolytically unstable. The low electrical resistivity and very high dissipation factor make its use questionable around electrical equipment. Before this oil is used in any application, the designer should consult a list of compatible materials available from the manufacturer.

Properties of MIL-L-6085A⁽¹⁾ (Synthetic Sess Fluid)

	(symenact		,	
				Method
Visconity contints	167 -	1000 0	1100 -	
Viscosity, centiatokes, at:	35° P	100° F	150° F	
0 paig				
3,000 paig 5,000 paig				See NSRDL
8,000 paig				Annapolis Report
10,000 paig	1			MATER 2 550
15,000 paig				
20,000 paig				1 -
			j	1
				\
Viscosity, centistokes, at 100° F,	12.7			
'				
Viscosity, centistokes, at 210° F,	3.31		J	ASTM D-445
O perg	, -			
Viscosity Slope, ASTR	0.709			
Lubricating Ability 4-Bali Wear Test, 30 min, 50° C.	!			Fed. Method 6505
52100 steel, average scar dia.,		•	ľ	(modified)
Drive steet, average scar dis.,				(45/011160)
ì kg	l	•	ŀ	1 -
3 kg				1-
5 kg			l	-
•				
			4	
		ì		
		i		}
Corrosion Protection]	Ì		xcm, n 445
Stirred Rust Test, 10% seawater, 140° F, 2 days				ASTM 0-665
On-Off Rust Test, 50% seawater,		ì		See Chapter 2
140° F, 50 days			İ	Test C-5
Ambient Pressure, coupon			Ì	See Chapter ?
stirred, corresion test, weight		!	ļ	Test C-1
change, mg		ĺ		
Copper	-225.3	-	-	-
Stainless Steel, 316	0	İ	j	-
Copper-Nickel (70-30)	- 2.6			-
Aluminum, QQ-A-250-4b	- 0.2	ļ	•	 -
Phosphor-Bronze	- 47.4	Ž.	1	-
Steel, galvanized	- 43.1	ļ	}	-
steel, 1009	- 2.4		į	-
Aluminum, QQ-A-250-11	0	ļ	ĺ	-
Bronze	- ჯმ.ე		ļ	i -
Monel Silver Base Brazing Milou	- 0.2		ı	-
Silver Base Brazing Alloy 20,000 "SIG Pressure-Cycled	- 48.9	į		See Chapter 7
Corrosion Test (1% seawater),	Ì		1	Test C-2
walqht change, my			İ	1
Insulated Specimens:]	ļ)
Copper			ĺ	-
Stainless Steel, 316		Ì	İ	-
Copper-Mickel (70-30)			į	_
Alumenum, 00-2-250-45	İ	i	i	-
Phosphor-Brongs			į	<u> </u>
Steel, galvamized			1	-
Steel, 1009	Ì		1	<u> </u> -
Aleminum, QQ-A-250-11			1	-
Bronse	j		4	-
Mon#1	1	1	1	; -
Silver hase arming Alloy	,	•		<u> </u>

	1				
Corrosion Protection (Cont)	1	1			Method
Electrically Coupled Specimens:	1	1	1		
Copper-Aluminum, QQ-A-250-11		1	1	l	-
Aluminum QQ-A-250-4b =	1		1		-
Copper-Nickel (70-50)	1	1	1		-
•		1			
None L-Bronze		1			-
Stainless Steel (316) -		1			-
Phosphor-Bronze	1	į			
Silver Base Brazing Alloy -]		•
Steel, 1004		I			
Aluminum QQ-A-250-11 -		İ		,	-
Bronze		1			
Aluminum QQ-A-250-4b =	1				-
Steel, 1009					
20,000 PSIG Stirred Corvosion	1	1	1		See Chapter ?
Test, weight change, mq					Test C-4
Insulated Specimens:			ļ		
Copper				•	-
Stainless Steel, 516					_
Copper-Nickel (70-50)		l			-
Atuminum, QQ-A-250-4b		l	1		-
Phosphor-Bronze		l			_
Steel, galvanized		l			_
Steel, 1009		l	!!!		_
Aluminum, QQ-A-250-11					
Bronze	ł				_
Mone l	ŀ				1
Silver Base Brazing Alloy					Ι.
Electrically Coupled Specimens:					-
Copper-Aluminum, QQ-A-250-11	ļ				_
Aluminum, QQ-A-21-0-4b -		į			_
Copper-Nickel (70-30)					-
Monel-Bronze		1			
Stainless Steel (516) -	ļ		1 1		•
, ,			1		-
Phosphor-Bronze		•			
Silver Base Braming Alic	ļ				
Stcel, 1009			i		
Aluminum, QQ-A-250-11 -	•	1	1		-
Bronze	ì		1		
Aluminum, QQ-A-2:0 4b -			1		•
Steel, 1009		l			
Pump Test		l			Proposed military
Average Weight Loss, my		ì		ï	specification for
Steel Gaars		1	<u> </u>		sea-water chulsi-
Bronze Bushings		1			fying oils
Corrosion Coupons, weight loss,	ļ	}			
each, my/cm'		1	j i	į	1
Copper		1	[į	-
Aluminum		i	[-
Steel, galvanized		l]	İ	-
Steel, 1009		ł			· 🛥
Silver Base Brazing Alloy		1]]		<u>.</u>
Dielectric Properties		ł] [ASTM D-1169 (mod-
Resistivity, 78° F, ohm-cm:	_				ified). See Chap-
As-Received	8.0×10 ⁸				ter 2 . Test E-1
With Sea-Water Contamination:					See Chapter 2
0.1% by volume				}	Test E-5
0.5% by volume					
2.Cz by volume					_
With Carbon Contamination:]]		See Chapter 2
0.1% wt/vol.					
0.25% wt/vol.				j	Test E-6
0.5% wt/vol.					-
0.50 Mr/ Ag1.					

			Method
Dislectric Properties (Cont)	ı		
After 50,000 Electric Arcs			See Chapter 2
(makes and breaks) at 90		j	Test E-7
volts, 10 amperes, resis-			
tive load			
Not filtered			-
Filtered			-
Solids generated, gram			-
Dissipation Factor, 76° F. \$			See Chapter ?
As-Received	>60	1 1 1	Test E-2
With Sea-Water Contamination;	,	 	See Chapter 2
0.1% by volume			Test E-5
0.5% by volume			-
2.0% by volume			-
With Carbon Contamination:			See Chapter 2
0.10% wt/vol.		1 1	Test E-6
· · · · · · · · · · · · · · · · · · ·		1 1 1	
0.25% wt/vol.		1 1	
0.50% wt/vol.			1 -
After 50,000 Electric Arcs			i .
(makes and breaks) at 90			I
volts, 10 amperes, resis-			1
tive load			1
Not filtered			-
Filtered			1 -
Solids generated, gram			
Dielectric Breakdown Voltage,			ASTN D-877 (mod-
0.05-inch gap, 78° F, kv			ified). See Chap-
As received	26.8		ter 2. Test E-3
With sea-water contamination:			See Chapter 2
0.1% by volume			Test E-5
0.5% by volume			1 -
2.0% by volume			-
With carbon contamination:			See Chapter 2
			Test E-6
0.10% wt/vol.			
0.25% wt/vol.			1 _
C.50% w+,'vol.			1
After 50,000 electric arcs			
(makes and breaks) at 90			
volts, 10 amperes, resis-			
tive load .			
Not filtered			-
Filtered	ļ		-
Solids generated, gram			
Contact Life, silver-cadmium, 50			See Chapter 2
volts, 10 amperes, resistive			Test E-8
load, 6000 psi, 65°-85° F		1 1	
Number of tests			-
Operations to failure (range)			
Emulsion Stability			
Paddle Test, after 1-hour set-			ASTN D-1401
tling:	8	1 1	_
Oil, ml			1 _
Emulsion, ml	72		1 _
Water, ml	0		See Chapter 2
Electric Probe Test, time for	l		Test E-4
water separation, min		1 .	See Chapter 2
Material Compatibility Static 20KPST			-
Butyl	Poor	1 1	Test C-3
Buna N	Fair		-
Viton B	Good		-
Ethylene-Propylene	Poor		
Tetrafluoroethylene (Teflon)	Good		-
Neoprene	Poor		-
Thickol	-		-
Silicone	Fair		-
,	1 .	1 1 1	l -
Fluorosilicone	Good		

***********		1			Method
Volatility Toxicity		1		1	•
Density, grams/cubic centimeter, at:	Synthetic 35 F	100° F	150° F		
O psiq	122 -	100 7	130 -	{	See NSRDL
5.000 psiq	ı		-		Annapolis Report
5,000 paig			i		NATLAB 550
8,000 paig	1	l			1
10,000 psig		ł			
15,000 psig		İ		ŀ	
20,000 prig	. i				
Isothermal Compressibility, volume	35° F	100° F	150 F		
decrease, %, at:					See NSRDL
O psig	1				Annapolis Report
3,000 paig					HATLAB 550
5,000 paig					
8,000 psig	1			·	
10,000 psig]		ļ		
15,000 psig					
20,000 psiq Chemical Stability	- 				
Oxidation Stability Test, 203° F,					ASTM D-943
hours to failure	1		l		ASIN DEST.
Oxidation Stability Test, 250° F					Fed. Method 5308
Hydrolytic Stability Test					Military specifi
Specimen change, mg					cation MIL-II-
Specimen appearance				·	19457В
Fluid acid number increase,					-5151-
mg KOH/gram fluid			İ		1
Water acidity, mg NOH					-
Insolubles, 🐔					-
Thermal Stability Test			l	,	-
Fire Resistance			1		İ
Flash Point, °F	385		ĺ		ASTN D-92
Fire Point, *F	j i/tO		1		ASTN D-92
Autogeneous Ignition Temperature, *	F		Ì		ASTM D-2155
High-Pressure Spray Combustor	}		Ī		See MEL Report
Minimum spontaneous ignition temperature, *F			ł		31/66 of March
Minimum reaction temperature,					1967
*F	ŀ				•
No indication of fire, °F	1		İ		_
Maximum pressure change, psi					<u>-</u>
Lowest temperature of maximum	1				[
pressure change, *F	1				
Temperature range explored, *F	1				
Hiscellaneous Properties					
Pour Point, F	<-70				ASTN D-97
Foaming Tendency, 75° F			l		astm d-892
Foam after 5-minute aeration,			1		i -
ml	1]		
Time out, minutes			Į		l -
Foam after 10-minute settling,	1				-
ml					_
Neutralization Number, mg KOH/gram	1		}		ASTN D-974
Water Content, \$ by weight	1				ASTM D-1744
Neutrality, qualitative	İ				Fed. Method 5101
Contamination	اما				SAE Method ARP-
Number and size of particles an fibers in 100-ml fluid	٦				598
25_100 micrometers					790
100-500 micrometers	1				
over 500 micrometers	j				1 -
particles over 250 microm-	j				I -
eters except fibers (length					
ten times diameter)	1				
Gravimetric Value, mg/100 ml	1				SAE Method ARP-7
Specific gravity at 60/60° F	1				ASTr. D-1298
Color	1				ASTM D-1500
Cost \$/gal	\$10.00				-
	gov. spec		i		l

Availability qov. spec.

Determinations made at atmospheric pressure, unless noted.

Supplementary Properties of NIL-L-6085A $^{(1)}$

Material Compatibility with		Method See Chapter 2
Hatural Businer	Poer	Test C-3
Polywenthenu	Poor	1
Busa 8	Foor	1

Section 1

^{*}Based on atmospheric preceure data.

MIL-L-7808G

Suggested Uses and Possible Limitations

The fluid covered by MIL-L-7808G is a synthetic-base material. It was developed originally as a lubricating oil for aircraft gas turbine engines. The atmospheric viscosity indicates that MIL-L-7808G would be a general-purpose fluid with a depth capability of 5000 feet. This fluid provides some limited corrosion protection. It has poor hydrolytic stability. Caution should be used in applying this fluid to electrical equipment since its resistivity and its dissipation factor are borderline, and no data are presently available under arcing conditions. Before using this fluid the system designer should consult a list of compatible materials available from the manufacturer.

0

Properties of NIL-L-7808F⁽¹⁾ (Synthatic Base Fluid)

'	a Au cua e re	Base Fluid	u)		
					Method
Viscometric Properties	1		_		
Viscosity, centistokes, at:	35° P	100° F	150° F		j
0 paig					
3.000 paig	j]			See NSRDL
5,000 paig	ł	ì			Annapolis Report
8,000 pmig	1		}		MATLAB 350
10,000 paig	ļ] -
15,000 pmig	1	1			-
20,000 pmig	ł	1] -
	1				į
	į.	1			į
	ł	1			İ
	· ·				
	l	i i			
101 1411 1411 1411	10.70				
Viscosity, centistokes, at 100° F,	17.50				
Viscosity, centistokes, at 210° F,	4.50				ASTM D-445
O paig	1 0 600	}			
Viscosity Slope, ASTM Lubricating Ability	0.629	 			
4-Ball Wear Test, 30 min, 50° C,	l		l		Fed. Method 6503
52100 steel, average scar dia	l	1 1	ļ		(modified)
mm:	1	! !	' i		("COLLIEG)
1 kg	l	j [
j kg	ł	1 1	1		
5 k g		;	l		
) hy	ł	1 !	ì		-
	1]			
	Í	[[ĺ		
], [1
	1				
	l	; !	}		
Corrosion Protection	1	[
Stirred Rust Test, 10% seawater,	Pass]	}		ASTM D-665
140° F, 2 days	l				
On-Off Rust Test, 50% seawater,	ļ]]	}		See Chapter ?
140° F, 30 days	ļ		i		Test C-5
Ambient Pressure, coupon	l]]	ļ		Jee Chapter 2
stirred, corrosion test, weight	1	i I	-		Test C-1
change, mg	_		j		ļ
Copper	-3.3				-
Stainless Steel, 316	-0.1)		-
Copper-Nickel (70-30)	-0.1		ļ		-
Aluminum, QQ-A-250-4b	-0.1]	J		-
Phosphor-Bronze	-0.8				-
Steel, galvanized	-1.0		1		-
Steel, 1009	+0.1		ļ		-
Aluminum, QQ-A-250-11	-0.1		1		*
Bronze	-0.8		į		-
Monel Silver Base Brazing Alloy	-2.6 -0.4	ļ Ì	}		-
Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled	-0.4	ļ į]		See Chapter 2
Corrosion Test (1% seawater),	ł	i !	}	1	See Chapter 2
weight change, mg		}	ĺ		Test C-5
Insulated Specimens:	l		1		
Copper		!	i		_
Stainless Steel, 316			ł	1	
Copper-Nickel (70-30)		l	ļ		_
Aluminum, QQ-A-250-4b		1	1		<u> </u>
Phosphor-Bronze	ļ		į		
Steel, galvanized		1	Į.		_
Steel, 1009]		!		~
Aluminum, QQ-A-250-11			- !		
Bronze]	ĺ	ł		-
Monel			ĺ		_
Silver Rase Brazing Alloy	[1	i i		_
DIIVEL LOSE BLUEING BLION	L				

	·			-	
Mark and an Amaka and Amark	}		1		Method
Corrusium Protection (Cont)	ì		Į.		1
Electrically Coupled Specimens:		}	1]) -
Copper-Aluminum, QQ-A-250-11	·]	į	ļ		ļ -
Aluminum QQ-A-250-4b -	1	1		ł	1 -
Copper-Nickel (70-50)	1	1	ł		
honel-Bronze	ŀ	1	1		ļ -
Stainless Steel (316) -	ì	1	1)) ··
Phosphor-Bronze	1				
Silver Base Brazing Allov - Steel, 1004	}	ì		1	} -
Aluminum QQ-A-250-11 -	}	1	ł	ł	İ
Bronze	ļ	1	1		1 -
Aluminum QQ-A-250-4b -	1	i .	Į.	ļ	
Steel, 100	1	ł .	ì	i	1 -
20,000 PSIC Stirred Corrosion	ł	ł	1	1	See Chapter 2
Test, weight change, mg	l	ł	1	ł	Test C-4
Insulated Specimens:		1			1686 6-4
Copper	1	1	i	1	į
Stainless Steel, 316	ŧ	1	1	ì	-
Copper-Nickel (70~30)	ł	ł	1		1 -
Aluminum, QQ-A-250-4b	ļ	1	1		ļ -
Phosphor-Bronze	1	1	i		<u> </u>
Steel, galvanized	ł	Į.	ł	ł	ł <u>-</u>
Steel, 1009	i	1	ł	ł	1 -
Aluminum, QQ-A-250-11	1	l			\ _
Bronze	1	1	{	ļ	1 [
Monel		Į.	ì	l	1]
Silver Base Brazing Alloy	1	1	İ		1 🗆
Electrically Coupled Specimens:	i	1	ļ	1	1 -
Copper-Aluminum, QQ-A-250-11	L .	ĺ	1	ĺ	(<u> </u>
Aluminum, QQ-A-250-4b -	1	į.	(}	1 _
Copper-Nickel (70-30)	1	ĺ	İ		1 -
Monel-Bronze	ł			ļ	1 _
Stainless Steel (516) -	i				<u> </u>
Phosphor-Bronze	1			ļ ì	
Silver Base Brazing Allo -	Í	1	1		[_
Steel, 1009	ì	ł	1		1
Aluminum, CQ-A-250-11 -	1		İ		l _
bronze	Í	ľ	Į.		Į.
Aluminum, QQ-A-2%0-4b -		1	ĺ		1 -
Steel, 1009	1	!			
Fump Test		Ì			Proposed military
Average Weight Loss, mg	1	1	1		specification for
Steel Gears	ĺ	ĺ	!		sea-water emulsi-
Bronze Bushings	Ì	i	i i		fying oils
Corrosion Coupons, weight loss,	1				, ,
each, mg/cm ²	!	l			
Copper	1	1	(-
Aluminum	ì	ł			i _
Steel, galvanized		[1		-
Steel, 1009	ĺ	1			- ·
Silver Base Brazing Alloy	[[[_
Dielectric Properties	ĺ	ĺ			ASTM D-1169 (mod-
Resistivity, 76° F, ohm-cm;	2.2×10 ¹⁰	!	ļ		ified). See Chap-
As-Received		i			ter 2. Test E-1
With Sea-Water Contamination:					Se∈ Chapter 2
0.1% by volume	[[Test E-5
0.5% by volume	j	}			
2.0% by volume]]			-
With Carbon Contamination:]	l į	ļ		See Chapter 2
0.1% wt/vol.	1 i			:	Test E-6
0.25% wt/vol.					-
0 SE we from	;	i	i i		l

U

Dielectric Properties (Cont)		1		1	Method
After 50,000 Electric Arcs	1	1	1	1	
(mokes and preaks) at 90	ł	1	ł	1	See Chapter 2
volta, 10 amperes, resis-	1	1	Ì	1	Test E-7
tive load	}]			
Not filtered	ļ	ł	ł	1	l
Filtered	1		1	ļ	ļ -
	j	}	}	j	-
Solids generated, gram	l l	1		1	-
Dissipation Factor, 76° F, %	1	1	Į.	1	See Chapter 2
As-Received	5.5	1	1	1	- Test E-2
With Sea-Water Contamination;	ļ	j	1	1	See Chapter 2
0.1% by volume	j]	1	}	- Test E-5
0.5% by volume	1 .	ı	ì		! -
2.0% by volume		1	j	1	
With Carbon Contamination:	1		J	}	See Chapter 2
0.10% wt/vol.	i	Ì			- Test E-6
0.25% wt/vol.	1	1	1	1	
0.50% wt/vol.	1	1	1		_
After 50,000 Electric Arcs	1	1	ĺ	i	1
(makes and breaks) at 90	1]	j	J	1
volts, 10 amperes, resis-	ļ	1			
tive load	1	1	1	1	(
Not filtered	1	ſ		[1 _
Piltered	I	ſ	Í	1	1 ~
Solids generated, gram	1			1	-
Dielectric Breakdown Voltage,	ł	1	i	}	ASTM D-877 (mod-
0.05-inch gap, 76° F, kv	1	ł	· l	}	
As received	05.6	ı	1	1	ified). See Chap
	25.6	1	}	1	ter 2. Test E-3
With sea-water contamination:	1	1	1	ļ	See Chapter 2
0.1% by volume	· J	j	}	1	- Test E-5
0.5% by volume		1	1	1	•
2.0% by volume	ł	1	1	}	-
With carbon contamination:	1	1	1	ļ	See Chapter 2
0.10% wt/vol.	}	1	1	j	- Test E-6
0.25% wt/vol.	1	1	1	Į) -
0.50% wt/vol.	ļ	1		j	-
After 50,000 electric arcs	j]	j] .
(makes and breaks) at 90	İ	Į.	i	•	· ·
volts, 10 amperes, resis-	1	(ĺ	[Ţ.
tive load	İ	ļ	ļ		1
Not filtered	1	i	ĺ	I	l <u>-</u>
Filtered	1	(1	i	
Solids generated, gram		ì	1	ļ	1 2
Contact Life, silver-cadmium, 50				Ī	See Chapter 2
volts, 10 amperes, resistive	ļ		ĺ	1	Test E-8
load, 6000 psi, 65°-85° P	1	1		į .	1000 200
Number of tests	1	1		Ì	1
Operations to failure (range)	İ	i .	1		1 -
mulsion Stability	ł		1	}	1
	1	1	ł	ł	1 name = 1001
Paddle Test, after 1-hour set-	1	ł	1	Ì	ASTM D-1401
tling:	_	ļ		Į	j
Oil, ml	5	j	1	j) -
Emulsion, ml	78		}		 -
Water, ml	0	ŀ	ì		-
Electric Probe Test, time for	1	}	}		See Chapter 2
water separation, min	ļ	1	J .		Test E-4
aterial Compatibility Static 20KPSF	1	1)		See Chapter 2
Butyl	Poor	Į			Test C-3
Buna N	Fair	1			-
Viton B	Good	[į į		1 -
Ethylene-Propylene	1	1			1 -
Tetrafluoroethylene (Teflon)	Poor	ĺ	1		1 -
Neoprene	Good	1	1		1 _
Thiokol	Poor	1	i i		1 _
	, -	1	l i		ļ -
Silicone	Fair				

					Method
Corrugion Protection (Cont)	1	1	1	1	1
Electrically Coupled Specimens		1	1	1	1 -
Copper-Aluminum, QQ-A-250-11 Aluminum QQ-A-250-46 -	'		1	!	1 -
Copper-Nickel (70-50)	1	1		1	· -
Nonel-Bronze	1	ł	}		1
Staipless Steel (516) -	i	1 .	.]		1 [
Phosphor-Bronze	Ī	İ	1		1
Silver Mase Brazing Alloy -	1	1	1 .		1 -
Steel, 1004	ì	İ			·
Aluminum QQ-A-250-11 -	ł	1			-
Bronze	1	į			1
Aluminum QQ-A-250-4b -	1		1	}	l -
Steel, 1009]	ļ	1	ļ	
20,000 PSIG Stirred Corrosion	1	ļ		į	See Chapter ?
Test, weight change, mg		1	1		Test C-4
Insulated Specimens:	l	1	1		
Copper Stainless Steel, 316	1	ł	1		-
Copper-Nickel (70-30)	1	Ì	1		-
Aluminum, QQ-A-250-4b	1	ł	!		•
Phosphor-Bronze	1	ł	1		_
Steel, galvanized	1	ł	l .		_
Steel, 1009	1	ĺ	i		_
Aluminum, QQ-A-250-11	[1	[<u>-</u>
Bronze		ļ	j		-
Mone]	1				-
Silver Base Brazing Alloy			i		•
Electrically Coupled Specimens:					
Copper-Aluminum, QQ-A-250-11	· [1			-
Aluminum, QQ-A-250-4b -	ļ	1			-
Copper-Nickel (70-30)					
Monel-Bronze Stainless Steel (316) -	}	1	1		-
Phosphor-Bronze	i	ł			-
Silver Base Brazing Allo -	1	1	1		_
Steel, 1009	Ì	1	1		_
Aluminum, QQ-A-250-11 -	ł	l	i i		-
Bronze	1				
Aluminum, QQ-A-2:0.4b -	ļ		1 1		-
Steel, 1009	[1	1 1		i
Pump Test	ļ	ļ	J j		Proposed military
Average Weight Loss, mg	l		}		specification for
Steel Gears]	}]]		sea-water emulsi-
Bronze Bushings		ļ	!		fying oils
Corrosion Coupons, weight loss, each, mg/cm ²	1	1	i		
Copper	ł		} i		_
Aluminum	1	1			
Steel, galvanized		1	i i		_
Steel, 1009		ļ	1 1	İ	_
Silver Base Brazing Alloy		j			-
Dielectric Properties	ĺ	ſ]	1	ASTM D-1169 (mod-
Resistivity, 76° F, ohm-cm:	2.2 x10¹⁰) i	ļ	ified). See Chap-
As-Received	1		; }		ter ?. Test E-1
With Sea-Water Contamination:	ļ		j j	ļ	See Chapter 2
0.1% by volume	İ				Test E-5
0.5% by volume			1	į	-
2.0% by volume With Carbon Contamination:	}		1		
With Carbon Contamination: 0.1% wt/vol.))		See Chapter 2
0.1% wt/vol. 0.25% wt/vol.]				Test E-6
0.25% WC/VOI.	ł		1		-

[]

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Biological Property Control	T -		7	T	Method
After 50,000 Electric Args	1		1		
(makes and breaks) at 90	1		1	Į.	See Chapter 2
volts, 10 ampares, resis-	ł	j	1	}	Test E-7
tive load	1	1	Ì	1	
Not filtered	ł	ł	ł	1	
Piltered	1	ı	1		-
Solids generated, gram	1	1	1		
Dissipation Pactor, 76° F. \$		1	ł	1	See Chapter ?
As-Received	5.5	i	İ	l	- Test E-2
With Sea-Water Contamination:		i	j	Í	See Chapter 2
0.1% by volume	1	ì	1	İ	- Test E-5
0.5% by volume	j	1	[1	1 -
2.0% by volume	j	j	1	}) -
With Carbon Contamination:)	1	-	1	See Chapter 2
0.10% wt/vol.	}	1	j	1	- Test E-6
0.25% wt/vol.	Į	}		ļ	\ -
0.50% wt/vol.	1	ł	ļ	1	! -
After 50,000 Electric Arcs	ł	1	1	}	1
(makes and breaks) at 90 volts, 10 amperes, resis-	!	1	1	}	
tive load	ł		1	1	1
Not filtered	İ	Ì	i	(ţ
Filtered	1	ì	i		1 -
Solids generated, gram	1	ł	1	1	-
Dielectric Breakdown Voltage,	1		Ì		ASTM D-877 (mod-
0.05-inch gap, 76° F, kv	1	1	1	1	ified). See Chap-
As received	25.6		ì	1	ter 2. Test E-3
With sea-water contamination:			i		See Chapter 2
0.1% by volume	1	1	[j	- Test E-5
0.5% by volume	ł	1	1	1	1 -
2.0% by volume	1		[j	-
With carbon contamination:	1)	1	1	Sec Chapter 2
0.10% wt/vol.	1		1	1	- Test E-6
0.25% wt/vol.	1	1	1	1	1 - 1
0.50% wt/vol.	1	1	1	1	1 - 1
After 50,000 electric arcs (makes and breaks) at 90	ł	1	ł	1	1
volts, 10 amperes, resis-	ļ	1	1		1 1
tive load	1	1	ł	ķ	1
Not filtered		1	1	1	{ _
Filtered	İ	1	1	1	1 -
Solids generated, gram	Į	1	1	1	1 - 1
Contact Life, silver-cadmium, 50			1	Ì	See Chapter 2
volts, 10 amperes, resistive	İ	İ	1	1	Test E-8
load, 6000 pmi, 65°-85° F	1	1	j	j	
Mumber of tests		1	1	1] -
Operations to failure (range)	1	1	}	ļ] [
Emulsion Stability	l .	}	1	Į	
Paddle Test, after 1-hour set-	1	ł	1	1	ASTM D-1401
tling:	}]	1	1]
Oil, ml	2	ļ	i	1	-
Emulsion, ml	78	}	}	}	-
Water, ml	0	1	}	1	
Blectric Probe Test, time for water separation, min	1	1	1	1	See Chapter 2 Test E-4
water separation, min Material Compatibility Static 20KPSI*	ł	1	ł	i	See Chapter 2
Butyl	į	Ì	j		- Test C-3
Buna #	Poor	}	1		- 1000
Viton B	Fair	1	1		-
Ethylene-Propylene	Good	l	1	ì	
Tetrafluoroethylene (Teflon)	Poor Good		1	i	_
Neoprene	Poor		1		_
Thickol	-	1	Ì		_
Silicone	Pair	1	1	[- 1
Fluorosilicone	Good	ł	1		- 1

Fluorosilicone
*Based on atmospheric pressure data.

	·	 		 Me tho i
Volatility			l i	-
Toxicity	Synthetic			_
Density, grams/cubic centimeter, at:	750 1	100 F	150 F	
0 psiq		 		Sec NSRDL
5,000 psig	i		l i	Annapolis Report
6,000 paid	į		1	MATLAB 550
8,000 paid	Ī	ł		
10,000 pary	ł			
15,000 psig				
20,000 psij				
Isothermal Compressibility, volume	31,0 F	100 F	ILO F	
decrease, %, at:				Sec NSRDL
0 psiq	İ		1	Annapolis Repert
3,000 рвіч	1	ļ	[]	MATLAB 550
5,000 psig	1		1	
8,000 psig	1			
10,000 paig				
15,000 psig	İ	İ		
20,000 psig	İ	1		
Chemical Stability		Τ		
Oxidation Stability Test, 203° F.		1	[ASTM D=943
hours to failure			<u> </u>	
Oxidation Stability Test, 250° F	1		}	Fed. Mothod 5308
Hydrolytic Stability Test	}			Military specifi-
Specimen change, mg	1	0.11		cation MIL-H-
Specimen appearance	İ	satisfac		19457в
Fluid acid number increase,	1	0.20	i 1	
mg KOH/gram fluid	İ	1		
Water acidity, mg KOH	1	-	1	-
Insolubles, %	1	nil		-
Thermal Stability Test			1	-
Fire Resistance		1		
Flash Point, °F	415			ASTM 5-98
Fire Point, °F	445	l	1	ACHM D=90
Autogeneous Ignition Temperature, of	7			AS. D-2155
High-Pressure Spray Combustor		j		See Mai Report
Minimum spontaneous ignition			i	31/66 of March
temperature, °F				1967
Minimum reaction temperature,	1	Ì	i I	-
°F	1			
No indication of fire, °F				-
Maximum pressure change, psi		ļ		-
Lowest temperature of maximum	ŀ		!	-
pressure change, F				
Temperature range explored, °F		ļ		-
Miscellaneous Properties		ŀ		1 C 1784 D 1377
Pour Point, F	<-40			ASTM D-97
Foaming Tendency, 75° F	ĺ	1	1	ASTM D-897
Foam after 5-minute aeration,	1	-		-
ml				
Time out, minutes]	_
Foam after 10-minute settling,		ļ		_
ml Neutralization Number my KOH/gram				ASTM D-374
Neutralization Number, mg KOH/gram Water Content, % by weight	ļ			ASTM D-1744
Neutrality, qualitative		1		Fed. Method '101
Contamination				
Number and size of particles and	4			SAE Method AFF-
fibers in 100-ml fluid	7			598
25-100 micrometers				
100-500 micrometers	1			_
ever 500 micrometers	}			1 -
pasticles over 250 microm-	Ţ		1	j _
eters except Tabers (length		1		
ten times diameter)		1		
Gravimetric Value, mg/100 ml				SAE M thod ARP- 5
	1 5			ASTA D.1 as
Specific gravity at 60/bJ°F Color	3.9.3			ASTM D-1 (C
	\$5 10			-
Cost \$/gal Availability	gov. spe	٠.		_
23 7 14 A 2 14 A 4 A 4 A 5 A 5	<u> </u>			 —

Availability gov. spect.

Determinations made at atmospheric pressure, unless noted

Sumplementary Properties of MIL-L-7808 $\mathbf{r}^{(1)}$

Material Compatibility wi	hr	Method See Chapter 2 Test C-)
Matural Rubber	Poor	1000 0.5
Polyurethane	Poor	
Buna S	Poer	
İ	1	į .

[&]quot;Based on atmospheric pressure data,

MIL-L-7870A

Suggested Uses and Possible Limitations

The fluid covered by the Military Specification MIL-L-7870A is a petroleum-base fluid developed for a low-temperature, general-purpose lubricant. The atmospheric pressure viscosity of MIL-L-7870A would lead to the prediction that it would be suitable for a general-purpose fluid for depth capability of 8000 feet. Its resistivity is low and its dissipation factor is high, making its use around electrical equipment questionable. It offers some limited corrosion protection. The low flash and fire points indicate that this fluid is readily flammable.

Properties of MIL-L-7870A(1) (Petroleum Base Fluid)

	Petroleus	PERSON PLU	ira)		
					Nethod
Viscometric Properties	750 7				
Viscosity, c tistokes, at: O psiq	35° P	100° F	150° F		
3,000 paig	ł	1			See NSRDL
5,000 paig			i		Annapolis Report
	1				HATLAB 350
8,000 psig 10,000 psig	}				AATEM JOO
15,000 paig					1 -
20,000 psig	1				1 _
20,000 paid					1
	l i		ł i		4
					1
	1				1
	1			,	
					1
	l l				
Viscosity, centistokes, at 190° F.					1
Viscosity, centistokes, at 210° F,	2.52				ASTN 0-445
O paig]]				1
Viscosity Slope, 7.STM	0.927			,	↓-
Lubricating Ability	1 1				Fed. Method 3503
4-Ball Wear Test, 30 min, 50° C,	1				
52100 steel, average scar dia.,	1 1				(modified)
mm:	1				
1 kg	{				
3 kg	1 1				1 -
5 kg	1 l				1 -
					1
	1 1				1
	ļ [
Corrosion Protection	1_ 1				1
Stirred Pict Test, 10% seawater,	Pass				astn d-665
140° F, 2 days	1 1				
On-Off Rust Test, 50% seawater,	}				See Chapter 2
140° F, 30 days	1 1				Test C-5
Ambient Pressure, coupon	1 1				See Chapter 2
stirred, corrosion test, weight) }				Test C-1
change, mg	i				
Copper	-39.7				-
Stainless Steel, 316	+ 0.1				-
Copper-Nickel (70-30)	- 2.0				1 -
Aluminum, QQ-A-250-4b	+ 0.2		ļ ļ		! -
Phosphor-Bronze	-15.8				-
Steel, galvanized	- 0.6				-
Steel, 1009	- 0.4		i		-
Aluminum, QQ-2-250-11	+ 0.4		<u> </u>		1 -
Bronze	- 6.6				-
Monel	- 2.2		1	*	-
Silver Base Brazing Alloy	-10.3				
20,000 PSIG Pressure-Cycled	! !				See Chapter 2
Corrosion Test (1% seawater),	[]				Test C-2
weight change, mg] }				
Insulated Specimens:	j l				
Copper					-
Stainless Steel, 316			j		-
Copper-Nickel (70-30)					-
> 1					-
Aluminum, 22-A-250-4b					1 -
Phosphor-Bronze					
Phosphor-Bronze Steel, galvanized					-
Phosphor-Bronze Steel, galvanized Steel, 1009					-
Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11					-
Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, 99-A-250-11 Bronze	ار				-
Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11	.				-

	 -	·			
Corresion Protection (Cont)			1		Method
klectrically Coupled Specimens:	1	1			_
Copper-Aluminum, w-A-CO-11	1	1			1 -
Aluminum QQ-A-24-U-4b -		İ			
Copper-Nickel (70-40)	1	1	1		-
None1-Bronze	1	i			_
Stainless Steel (416) -	[l			_
Phosphor-Bronze					_
Silver Base Brazing Alloy -					-
Steel, 1004			}		
Aluminum 22-A-250-11 -		i	1		-
Pronze	1		1		
Aluminum QQ-A-TFC-4b -			1		-
Steel, 1009			1		
20,000 PSIG Stirred Corrosion		l	i		See Chapter ?
Test, weight change, mg	1				Test C-4
Insulated Specimens:	1			+	
Coppe :		j			-
Stainless Steel, 316					-
Copper-Nickel (70-30)	l				•
Atuminum, QQ-A-250-4b	l	İ			-
Phosphor-Bronze		1			
Steel, galvanized		i	1 1		-
Steel, 1009					-
Aluminum, QQ-A-250-11			!		-
Bronze None l					-
Silver Base Brazing Alloy	•		1 1		-
Electrically Coupled Specimens:	ĺ	1	1		-
Copper-Aluminum, QQ-A-250-11			1		
Aluminum, QQ-A-2:00-4b -		1	1		***
Copper-Nickel (70-30)	İ		1		-
Honel-Bronze	† 1				
Stainless Steel (316) -	i]		•
Phosphor-Bronze	ļ				_
Silver Base Brazing Allo	l		i		_
Steel, 1009	i		1		
Aluminum, QQ-A-250-11 -	ļ				_
Bronze	:		1 1	į	
Aluminum, QQ-A-750-4b -			1		_
Steel, 1009			}		
Pump Test	1		1		Proposed military
Average Weight Loss, mg					specification for
Steel Gears					sea-water emulsi-
Bronze Bushings					fying oils
Corrosion Coupons, weight loss,			1 1	1	
each, mg/cm ²	[1 1		
Copper			1		-
Aluminum	1		1		-
Steel, galvanized	1]		-
Steel, 1009			1]	-
Silver Base Brazing Alloy					-
Dielectric Properties	1			I	ASTM D-1169 (mod-
Resistivity, 78°F, ohm-cm:] [ified). See Chap-
As-Received	7.6×10 ⁹		1 !		ter 2. Test E-1
With Sea-Water Contamination:				I	See Chapter 2
0.1% by volume			Į	ļ	Test E-5
0.5% by volume	Ì		1	I	-
2.0% by volume]	!	-
With Carbon Contamination:				j	See Chapter 2
0.1% wt/vol.	1		1	!	Test E-6
0.25% wt/vol.				1	-
0.5% wt/vol.	ــــــــــــــــــــــــــــــــــــــ		<u></u> L		*

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The second secon	Ţ 			T. Market
Dielectric Properties (Cont)				Method
Atter 50,000 Electric Arcs				See Chapter 2
(makes and breaks) at 90				Test E-7
volts, 10 omperes, resis-				
tive load	1			
Not filtered Filtered	ļ.			-
Solids generated, gram	-			-
Dissipation Factor, 78° F. %	14.4			- m - A
As-Received	1			See Chapter 1 Test E-2
With Sea-Water Contamination:				See Chapter ?
0.1% by volume				Test E-5
0.5% by volume				-
2.0% by volume				_
With Carbon Contamination:	I			See Chapter 2
0.10% wt/vol.	1			Test E-6
0.25% wt/vol.	ì			_
0.50% wt/vol.				-
After 50,000 Electric Arcs	1			
(makes and breaks) at 90]	1	
volts, 10 amperes, resis- tive load	1			
Not filtered				
Filtered	İ			ļ -
Solids generated, gram	1			
Dielectric Breakdown Voltage,	1			ASTM D-877 (mod-
0.05-inch gap, 78° F, kv	1]		ified). See Chap-
As received	30.4			ter 2. Test E-3
With sea-water contamination:				See Chapter 2
0.1% by volume				Test E-5
0.5% by volume				i -
2.0% by volume	[-
With carbon contamination:				See Chapter 2
0.10% wt/vol. 0.25% wt/vol.				Test E-6
0.50% wt/vol.				j -
After 50,000 electric arcs	1			-
(makes and breaks) at 90				1
voits, 10 amperes, resis-				
tive load				
Not filtered				
Filtered				-
Solids generaced, gram				-
Contact Life, silver-cadmium, 50			1	See Chapter 2
volts, 10 amperes, resistive	[1	Test E-0
load, 6000 psi, 65°-85° F		1	1	
Number of tests	i			-
Operations to failure (range) Emulsion Stability	}		Ī	
Paddle Test, after 1-hour set-				ASTM r -1401
tling:				1041- 1 WIEW
Oil, ml	2			
Emulsion, ml	78	1		_
Water, ml	0			_
Electric Probe Test, time for			1	See Chapter 2
water separation, min				Test E-4
Material Compatibility Static 20KPSI	<u> </u>			See Chapter 2
Butyl	Poor		1	Test C-3
Buna N	Good		i	-
Viton B	Good		1	-
Ethylene-Propylene	Poor			-
Tetrafluoroethylene (Teflon)	Good			-
Neoprene	Fair	1		-
Thiokol Silicone	Fair			•
Fluorosilicone	Fair	j l		_
1 INDIOBILITORE	EMTT	 	<u> </u>	-

*Based on atmospheric pressure data.

					Method
Volatility					And the state of t
Toxicity	Petroleum				-]
Density, grams/online centimeter, at:	31.8 1	100° F	1:0, 1	The same of the same of the same of	
C bard					See RSRDL
1,000 para					Annapolis Report
2,000 part					MATLAN (1/4)
10,000 psr4			į		
10,000 psiq			ì		
20,000 bari					1
inothermal Compressibility, volume		100. 1	TO THE STATE OF		
decrease, i, at:					See NSFDL
0 pstq					Annapolis Resourt
*,000 ps (4					OUN HAITAM
, '660 bard			}		
8,000 psr;			1		
10,000 pstd					
15,000 psiq 20,000 psiq					
Chemical Stability					
Oxidation Stability Test, 203° F.					ASTM D=943
hours to failure					
Oxidacion Stability Test, 250° F					red. Method (368)
Hydrolytic Stability Test					Eilitary specifi-
Specimen change, mg					cation MIL-H-
Specimen appearance					19457в
Fluid acid number increase,					
mg KOH/gram fluid					
Water acidity, mg NOH					-
Insolubles, % Thermal Stability Test					-
Fire Resistance					-
Flash Point, "F	285				ASTM D-OF
Fire Point, °F	310				ASTN D-92
Autogeneous Ignition Temperature, T					ASTM D-F155
High-Pressure Spray Combustor					Sec MEL Report
Minimum spontaneous ignition					31/66 of March
temperature, °F					1967
Minimum reaction temperature,					-
°F) t		1
No indication of fire, F					-
Maximum pressure change, psi					-
Lowest temperature of maximum pressure change, °F					-
Temperature ringe explored, °F					_
Miscellaneous Properties					
Pour Point, F	-70				ASTM D-97
Foaming Tendency, 75° F					ASTM D-892
Foam after 5-minute aeration,					-
ml	i i				
Time out, minutes					-
Foam after 10-minute settling,					-
ml Noutralization Number mg KON/gram					ACTM D 07/
Neutralization Number, mg KOH/gram Water Content, 5 by weight					ASTM D-974 ASTM D-1744
Neutrality, qualitative					Fed. Nethod 5101
Contamination					-
Number and size of particles and	,				SAE Nothod ARP-
fibers in 100-ml fluid					598
25-100 micrometers					-
100-500 micrometers					-
over 500 micrometers					-
particles over 250 microm-					- 5
eters except fibers (length			İ		
ten times diameter)					CAP Method ann con-
Gravimetric Value, mg/100 ml	A 8.26				SAE Nethod ARP-785 ASTM D-1298
Specific gravity at 70/60° F	0.876		Ì		ASTM D-1298 ASTM D-1500
Cost 3/gal	\$1.30				-
Availability	gov. spec				_

Determinations made at atmospheric pressure, unless noted.

Supplementary Properties of MIL-L-7870A(1)

Material Compatibility wit	اما	Method
	'፟፝፞፞፞፞፞፞፟	See Chapter 2
Buna S	Poor	Test C. 3
Natural Rubber	Poor	
Polyurethane	Good	
P.D. a. d. a. a. a. a. a. a. a. a. a. a. a. a. a.		1

^{*}Based on atmospheric pressure data.

MIL-C-8188C

Suggested Uses and Possible Limitations

The fluid covered by Military Specification MIL-C-8188C is a corrosion-inhibited, synthetic-based oil which was developed as a corrosion-preventive oil for the preservation of engines which operated on MIL-L-7808 oil. It has poor hydrolytic stability. The viscosity of MIL-C-8188C leads to the prediction that it could be used at depth capability of 6000 feet. Its poor dielectric properties make it unsatisfactory for use in electrical equipment. Before using this fluid, the system designer should consult a list of compatible materials available from the manufacturer.

Properties of MIL C 8188C(1) (Synthotic Base Fluid)

	(5)	Base Flu	10)	
Viscometric Properties	an armus sali Pela area			Method
Viscosity, centratokes, at:	55° F	100° F	1,0, E	See NSEDL Achapelis Report MATLAB 550
Viscosity, centistokes, at 100° F, Viscosity, centistokes, at 210° F, O psig Viscosity Slope, ASTM	14.14 3.90 0.645			ASTM D-44
Lubricating Ability 4-Ball Wear Test, 30 min, 50° C, 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg	;			Fed. Method 6577 (modified)
Corrosion Protection Stirred Rust Test, 70% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg insulated Specimens: Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy	-27.6 0 9.4 + 0.3 -12.7 - 1.7 0 + 0.2 - 8.0 - 1.8 - 7.7			ASTM D-665 See Chapter 7 Test C-5 See Chapter 2 Test C-1

and the second section of the section of the					
			1	1	Mothad
Cottos ton Protection (Cont)	1		1	1	
theet inally coupled Seconsons:	1	1			-
Cooper-Altestnum, CQ-A-150-11	1				-
Alaminum CC-A-11,0-46 -					1 -
Copper-Nickel (70-50)	ļ			i	ľ
Monel -Brenze	i	1			1 -
Starriess Steel (216) -		1	1	1	1 _
Planshing - bron.		i	1	i	
Silver Base Brazing Alloy .	İ	1	1		
•]	1	1		-
Steel, 1004]	!		i	•
Aluminum QQ-A-(**Q-11 -	ŀ	Į	1		·
Bronze	i	İ	1		
Aluminum 20-A-750-4b -					-
Steel, 1000	!	}	į	İ	
10,000 PSIG Stirred Corrosion			Į		See Chapter !
Test, weight change, mg			!		Test C-4
Insulated Species as:			Ī		İ
Copper					_
1	ļ		ļ		-
Stainless Steel, 316	l		i	I	-
Couper-Nickel (70-50)			1		-
Atuminum, QQ-A-750-46			ļ	1	i -
Phosphox-Bronze				1	-
Stock, galvanized		ļ			-
Steel, 1000					-
Alumot.um, QQ=A-25C-11	Ì				_
Bronze					-
Mone 1			1	ŀ	1 _
Silver Base Brazing Alloy				1	1 -
Electrically Coupled Specimens:	!		1		_
•		l			
Copper-Aluminum, QU-A-250-11				ŀ	-
Aluminum, QQ-A-P50-4b =		1	Í		-
Copper-Nickel (70-30)	i	l		}	·
Monel-Bronze	}		Į.		-
Stainless Steel (316) -		1	1		-
Phosphor-Bronze	1	I	ì	ĺ	
Silver Base Brazing Atto.		l			1 -
Steel, 1000		1		i	
Aluminum, 00-A-7;0-11 -		l			_
Sronze	:	ļ	ļ		_
		Ì	Ì		1
Aluminum, QQ-A-100-4b -	i		1		~
Steel, 1009			1		
Pump Test			1		Proposed military
Average Weight Loss, mg		İ		i	specification for
Steel Gears		1			sea-water enules-
Bronze Bushings					fying oils
Corresion Coupens, weight less,		i			
each, mg/cm2		Ì	i	İ	
Copper					_
		1	l		
Aluminum		l	l	I	-
Steel, galvanized		l			-
Steel, 1009		l			-
Silver Base Brazin; Alloy		l			-
Dielectric Properties					ASTN D-1169 (mod-
Resistivity, 78° F, ohm-cm:		ļ.			ified). See Chap-
As-Received	7.8×10 ⁸	ł			ter 2. Test E-1
With Sea-Water Contamination:	,				See Chapter 2
0.1% by volume					Test E-5
0.5% by volume					1030 249
I]			-
2.0% by volume					
With Carbon Contamination:		!			Sec Chapter 2
0.1% wt/vol.					Test E-6
9.25% wt/vol.					-
0.5% wt/vol.		ł			

	T			 Me : hod
Dielectric Properties (Cont)	1		- 1	
After 50,000 Electric Arcs	1			See Chapter 2
(makes and breaks) at 90	1		1	Test E-7
volts, 10 amperes, resis-	İ	1	l	,1
tive load	i	1 1	i	1.
Not filtered	ĺ	1 1		-
Filtered		1 1		j -
Solids generated, gram	_	1 1	j.	•
Dissipation Factor, 76° F. 🛠	>60	}		See Chapter 2
As-Received	f	1 1	i	Tost E-2
With Sea-Water Contamination;	ļ	1 1	1	See Chapter 2
0.1% by volume		1		Test E-5
0.5% by volume		1 1		i -
2.0, € by volume				
With Carbon Contamination:		!		See Chapter 2
0.10% w'/vol.	ļ.	.1		Test E-6
0.25% wt/vol.	!	"		-
0.50% w\/vol.		· -	1	-
After 50,000 Electric Arcs			l	İ
(makes and breaks) at 90		1	1	1
volts, 10 amperes, resis-			ì	•
tive load		1	ļ	ŀ
Not filtered		1	i	-
Filterel			ļ	-
Solids generated, gram		1	-	-
Dielectric Breakdown Voltage,				ASTM D-577 (mod-
0.05-inch gap. 78° F, kv		1		ified). See Chap-
As received	25.2		ľ	ter 2 . Test E-3
With sea-water contamination:			·	See Chapter 2
0.1% by volume		1		Test E-5
C.5% by volume		1 1		-
2.0≸ by volume		1	i	-
With carbon contamination:			1	See Chapter 2
0.10% wt/vol.		1	İ	Test E-6
0.25% vt/vol.		1	1	-
0.50% wt/vol.) i		l -
After 50,000 electric arcs			i	!
(makes and breaks) at 90		1	ŀ	
volts, 10 amperes, resis-		1	Ì	
tive load		1		
Not filtered		1	ļ	l -
Filtered		1 !	Í	l -
Solids generated, gram		1	į	l <u>-</u>
Contact Life, silver-cadmium, 50		1	1	See Chapter 2
volts, 10 amperes, resistive	İ	1 1		Test E-8
load, 6000 psi, 65°-85° F		1 1	1	
Number of tests] [1	l _
Operations to failure (range)		1	l	l
Emulsion Stability			[l
Paddle Test. after 1-hour set-		1 1	į	ASTM D-1401
tling:		1 1	j	1
Oil, ml	40	1	İ	_
Emulsion, ml	ō	1 1	[
Water, ml	40	1	ľ	
Electric Probe Test, time for	,,,	1 1	ļ	See Chapter 2
		1		Test E-4
water separation, min Material Compatibility Static 20KPSP		1 1	l	See Chapter 2
· · · · · · · · · · · · · · · · · · ·) !	İ	•
Butyl	Poor	ļ · 1	İ	Test C-3
Buna N	Fair	1		_
Viten B	Good	1 1		_
Ethylene-Propylene	Poor	1		-
Tetrafluoroethylene (Teflon)	Good	1		-
Neoprene	Poor	1	i	-
Thiokol		1 1	-	-
Silicone	Fair	1 1		 -
Fluorosilicone	Good	الــــــــــــــــــــــــــــــــــــ		 •

The same and the same of the s	·			the section of the section of business.	
Volatitity	Į	1	1		Me the of
Toxicity		Į.	1	l	
	Syntheti	d	L	İ.,	1
Density, 91 ms/cubic centuryer, at-	11.	100° F	1.0, 1.		1
C bar.			1		See BERDI.
5,000 paid	1,		1		Annapolis Report
, 5,000 pst-r	1		1	1	SATLAB SLC
8,000 para			l	<u> </u>	
10,000 psig	l			i	
16,000 paig		1	1		
20,000 part	ļ	1	1		
Isothermal Compressibility, volume	55. F	100° F	150 1		1
decrease, %, at:					See NSFbb
() Fiziti	1	!			Annapolis Report
3,000 psig	İ	1			MATLAN 350
5,000 parq	l	1			1
8,000 psty	l				1 !
10,000 paig	1	ļ			1 !
			1		
15,000 paig	l	1			
20,000 psig					
Chemical Stability					1
Oxidation Stability Test, 203° F,	l				ASTM D-94;
hours to failure	l				i
Oxidation Stability Test, 250° F	1				red. Method 5708
Hydrolytic Stability Test				! !	1 - 1
•	İ				Military specifi-
Sperimen change, mg	1	ļ i			cation NIL-H-
Specimen appearance	l				- <u>2</u> 4478
Fluid acid number increase,					-
mg KOH/gram fluid	İ				
Water midity, my KOH		i			_
Insolubles, %					
Thermal Stability Test					-
Fire Resistance					<u> </u>
	1 .				
Flash Point, F	455				ASIM D-OP
Fire Point, °F	500				ASTN D=02
Autogeneous Ignition Temperature, F					ASTN 0-2155
High-Pressure Spray Combustor	ĺ				See M.L Report
Minimum spontaneous ignition	!		i		31/66 of March
temperature, °F			1		1967
Minimum reaction temperature,					1,501
°F	1				- ' '
-					!
No indication of fire, °F					-
Naximum pressure change, psi					l
Lowest temperature or maximum					- 1
pressure change, °F			;		į į
Temperature range explored, °F					! <u>_</u>
Miscellaneous Properties					
Pour Point, F	<-75	1			ASTN D-97
Foaming Tendency, 75° F	<-15		1		
4	l	İ	ì		ASTN D-800
Foam after 5-minute aeration,					-
ml		i i]		į
Time out, minutes		1	1		•-
Foam after 10-minute settling,		1	1		
ml		!	ļ		ĺ
Neutralization Number, mg KOH/gram			1		200 n 07h
Water Content, 5 by weight		I	ı		ASTM D-974
		ŀ	į		ASTM D-1744
Neutrality, qualitative		!]		Fed. Method 5101
Contamination		l	!		i –
Number and size of particles and		[i	ļ	SAE Method ARP-
fibers in 100-ml fluid		i	i		598
25-100 micrometers	l	İ	1		
100-500 micrometers		ŀ	l		_
over 500 micrometers	ı		-		-
particles over 250 microm-			[-
•			ŀ		-
eters except fibers (length			ł		i
ten times diameter)			ţ		i
Gravimetric Value, mg/100 ml			-		SAE Method ARP-785
Specific gravity at 60/60°F	0.933	i			ASTM D-1298
Color			[į	ASTM D-1500
Cost \$/gal	\$5.30		l	1	
			- 1		-
VAGTIGNITICA.	gov. spec	<u></u>			

Availability

Determinations made at atmospheric pressure, unless noted.

Supplementary Properties of MIL-C-8188c(1)

		Method
Material Compatibility wit	ከተ	See Chapter 2
Natural Rubber	Poor	Test C-3
Polyurethane	Poor	
Runa S	Poor	
	· ·	

^{*}Based on atmospheric pressure data.

MIL-F-17111

Suggested Uses and Possible Limitations

The fluid covered by Military Specification MIL-F-17111 is a petroleum-base fluid which was developed as a hydraulic fluid for ordnance hydraulic systems. The viscosity at atmospheric pressure of MIL-F-17111 leads to the prediction that this fluid would be a satisfactory general-purpose fluid to depth capability of 5000 feet only. It provides some degree of corrosion protection and it is highly flammable. Initial dielectric properties are good, but additional information relating to its electrical application is lacking.

	(Petroleum	Base Flui	id)		
No.					Method
Viscometric Properties Viscomity, centistokes, atr	55° F	100° F	150° F	1	
C parq	- 22 F	150 F	150 1		
3,000 parg	İ	İ	ľ		Sec NSRDL
pieg 000,0	l .				Annapolis Report
8,000 ps ig	i		ľ		MATLAB 550
10,000 psiq					-
19,000 pstq	[[[
20,000 psiq					_
	1	[1		Ì
Viscosity, centistokes, at 100° F.	28.8	!			
Viscosity, centistokes, at 210° F,	10.14	1 .			ASTM D-445
0 psig		1			
Viscosity Slope, ASTM	0.391				<u> </u>
ubricating Ability		[- , , , , , , , , , , , , , , , , , , ,
4-Ball Wear Test, 30 min, 50° C,	}	1			Fed. Method 650
52100 steel, average scar dia., mm:					(modified)
mm: 1 kg	i	i '			
3 kg		<u> </u>			1
5 k g]			-
-					
Corrosion Protection					
Stirred Rust Test, 10% seawater, 140° F, 2 days	pass				ASTM D-665
On-Off Rust Test, 50% seawater,	pass	}	1		See Chapter 2
140° F, 30 days					Test C-5
Ambient Pressure, coupon					See Chapter 2
stirred, corrosion test, weight					Test C-1
change, mg Copper	+0.1				1_
Stainless Steel, 316	0 +0.1	}	}		-
Copper-Nickel (70-30)	0				_
Aluminum, QQ-A-250-4b	l ŏ]	ľ		-
Phosphor-Bronze	+0.2	ļ l			-
Steel, galvanized	-0.9				-
Steel, 1009	-0.4] }	}		-
Aluminum, QQ-A-250-11	+1.5				-
Bronze	0				-
Monel	-0.2		j		<u> </u>
Silver Base Brazing Alloy	-0.4		ļ		See Chapter 2
20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater),					Test C-2
weight change, mg		į l]		rest C-2
Insulated Specimens:	1		1		
Copper					_
Stainless Steel, 316		(į		-
Copper-Nickel (70-30)					-
Aluminum, QQ-A-250-4b	•	[[ľ		-
Phosphor-Bronze			1		-
Steel, galvanized			1		_
Steel, 1009			ļ		-
Aluminum, QQ-A-250-11			ĺ		-
Bronze	:		1		
Monel]	j		_
Silver Base Bra ing Alloy		Ll			<u> </u>

The state of the s	,			Springer of the second contraction	gramma de la compansa del compansa de la compansa d
					Method
Consider Protection (Cont)	ł	1	1	1	1
Electrically Complete Specimens:		1			-
Copper =Alamenta, pg =A = 0 = 11			ĺ		1 -
Aluminum QQ-A-1 0-4b -]	1	1		-
Coppet-Nickel (70-50)	İ	ĺ	l	į	į
Mone l-Bronze	ļ	ŀ		ļ	1 -
Stainless Steel (416) -			1		-
imospias altronse)		Ì)
Silver Broc Brazing Alley -	l	l	į.	Į.	l -
Steel, 100k	l	1	i		ł
Alucinus Qual-199411 -	İ	i		i	_
Becaze	i				
Aluminum eQ-A-PSC-4b -	•	1	1	1	١.
Steel, 1000	İ		l		
CO. OCO PSIG Stirred Correspon	(105 seaws		1	1	See Chapter >
Test, weight change, my	LIOS SCAWC	1001)			Test C-4
			1	1	Test C-4
Insulated Specimen :			ļ		
Copper	0	1	Í		-
Stainless Steel, '16	+0.1	İ	Ī		 -
Copper-Nickel (70-50)	+0.3	l	ļ	į.	
Aluminum, QQ-A-C50-4b	+0.1	l	l	l	-
Phosphor-Bronzo	0				-
Steel, galvanized	+0.3	l	1	1	-
Steel, 1009	+0.2	1	1	1	_
Aluminum, QQ-A-050-11	+0.1	1			_
Brenze	+0.4	1	1	1	
Monel		[1	l	
Silver Base Brazing Allov	+0.1	1	1	1	-
Electrically Coupled Specimens:	-0.3	1	ł	Ī	-
		•			
Copper-Aluminum, QQ-A-ChQ-11			Į.	i	-
Aluminum, QQ-A-250-41-	-0.1-0.1		Í		-
Copper-Nickel (70-20)			l	l	
Monel-Bronze	-0.110.2			1	-
Stainless Steel (316) -	+0.1 0	[!	l	-
Phosphor-Bronze		ł			
Silver Base Brazing Allo: -	+0.1+0.2	i			-
Steel, 1009		1	ł		
Aluminum, QQ-A-C_0-11 -	0 +0.3		1		-
Bronze		1		1	
Aluminum, QQ-A-250-1b -		ĺ			_
Steel, 1009	-0.1 0		1		
Pump Test	-0.1 0	}	ł	}	Proposed military
Average Weight Loss, my		ĺ	l		specification for
Steel Gears	_	{	{	}	sea-water emulsi-
- · · - · ·	6				fying oils
Bronze Bushings	2 5		{		., ing Oils
Corrosion Coupons, weight loss,	-		ŀ		
each, my/cm²			 		
Copper	0.01				-
Aluminum	0.03		l		-
Steel, galvanized	0.25		1		-
Steel, 1009	0.05				-
Silver Base Brazing Alloy	0.03				-
Dielectric Properties					ASTM D-1159 (mod-
Resistivity, 77° F, ohm-cm:	8.2x10 ¹¹				ified). See Chap-
As-Received					ter 2. Test E-1
With Sea-Water Contamination:					Chapter 2
0.1% by volume					Test E-5
0.5% by volume					
2.0% by volume		1			_
With Carbon Contamination:					Chamber C
					Chapter 2
0.1% wt/vol.					Test E-6
0.25% wt/vol.		ĺ			-
0 5% wt/vol.					-

production of the second by a second second contract of the second secon			
	1	1 1	Method
Dielectric Properties (Cont)	ļ		See Chapter ?
After 50,000 Electric Arcs	1	i i	Test E-7
(makes and breaks) at 90	Í		
volts, 10 amperes, resis-	1	1 1	1
tive toad	}	1	
	1	1 1	1
Not filterea	1		-
Filtered	1	1	1 -
Solids generated, gram	1	i i	
Dissipation Factor, 77° F, %	}	1 !	1 7 0 4 1 7 1
		1	See Chapter 2
As-Received	1.9	i i	Test E ?
With Sca-Water Contamination:		1	See Chapter ?
0.1% by volume		1	Test E-5
0.5% by volume	1	1 1	lese say
•			-
2.0% by volume	į.	1 1	1 -
With Carbon Contamination:		1 1	See Chapter 2
0.10% wt/vol.	i	[- Test E-6
0.25% wt/vol.	l	1	
•	į.	1 1	-
0.50% wt/vol.	1	1 1	-
After 50,000 Electric Arcs	1	1	1
(makes and breaks) at 90	1	i	1
volts, 10 amperes, resis-	I		
tive load	1	[[
1	1	1 1	1
Not filtered	1	1	! -
Filtered	J	j l] -
Solids generated, gram	-	1	1 -
Dielectric Breakdown Voltage,			ASTM D-877 (mod-
0.05-inch gap, 77° F. kv	1	1	
	i	1 1	ified). See Chap-
As received	23.2	1	ter 2. Test E-3
With sea-water contamination:	-,	1	See Chapter 2
0.1% by volume	1	1	Test E-5
0.5% by volume			1 1000 2-9
2.0% by volume	i	1 1	1 -
			1 -
With carbon contamination:	j) !	See Chapter 2
0.10% wt/vol.	ĺ		Test E-6
0.25% wt/vol.	ŀ	1	<u> </u>
0.50% wt/vol.		1 1	į į
4	ļ	1 !	1 "
After 50,000 electric arcs		1	1
(makes and breaks) at 90	ļ	!	}
volts, 10 amperes, resis-	1	1 1	İ
tive load			1
Not filtered		[1
		1	-
Filtered	i	1 '	i -
Solids generated, gram	1		-
Cortact Life, silver-cadmium, 50	ī	1	See Chapter 2
volts, 10 amperes, resistive	1		Test E-8
load, 6000 psi, 65°-85° F	!	1	Test E-O
	Ĭ	ļ l	
Number of tests	1	1 1	-
Operations to failure (range)	1]	[[
Emulsion Stability	í	1	
Paddle Test, after 1-hour set-	1	<u> </u>	ASTM D-1401
,	}	}	Note 0-1401
tling:	4	1	
Oil, mi	1	, }	! -
Emulsion, ml	79		-
Water, ml	1 6	i i	_
<u> </u>	Ι '		See Chanter C
Electric Probe Test, time for	1	i 1	See Chapter 2
water separation, mir.	1		Test E-4
Material Compatibility Static 20KPSP	1		See Chapter 2
Butyl	Poor	!	Test C-3
Buna N		1	
1	Fair-good	,	-
Viton B	Good	ı j	-
Ethylene-Propylene	Poor) I	-
Tetrafluoroethylene (Teflon)	Good		-
Neoprane	(1 i	_
	Fair		
Tniokol	-		ļ -
Silicone	Por	i i	~
Fluorosilicone	Poor	<u> </u>	

*Based on atmospheric pressure data.

					Method
Volatility					•
Toxicity	Petroleum				-
Density, grams/cubic centimeter, att	35° F	100°F	1.0, 1.		
0 ps1-j					See NSRDL
5,000 paig					Annapolia Report
5,000 baid					NATLAH 350
8,000 paig					
10,000 psig					
15,000 psiq 20,000 psiq			j		
isothermal Compressibility, volume	34, F	100° F	7.67		The same of the sa
decrease, A. at:					See NSEDL
0 psiq					Annapolis Report
3,000 psig					MATLAB 350
5,000 paid					
8,000 psiq					
10,000 psig				:	İ
15,000 paig					
20,000 psiq					
Chemical Stability					
Oxidation Stability Test, 203° F.					ASTN D-943
hours to failure					Fed. Method 5308
Oxidation Stability Test, 250° F			l		Rilitary specifi-
Hydrolytic Stability Test					cation MIL-II-
Specimen change, mg	,				19457B
Specimen appearance Fluid acid number increase,]				194,710
mg KOH/gram fluid					_
Water acidity, mg KOH			1		١ ـ
Insolubles.		1			_
Theiral Stability Test					l _
Fire Resistance	l				[
Flash Point, °F	>220				ASTN D-97
Fire Point, °F	>235		1		ASTN D-92
Autogeneous Ignition Temperature. 1]		ASTN 0-2155
High-Pressure Spray Combustor	}	l			See MEL Report
Minimum spontaneous ignition			1		31/66 of March
temperature, °F	l	Ì	ĺ		1967
Minimum reaction temperature,	1		}		- `
*F		ļ			
No indication of fire, °F					-
Maximum pressure change, psi		į.			-
Lowest temperature of maximum					-
pressure change, °F Temperature range explored, °F		1			1_
Miscellaneous Properties Pour Point, F	<-40				ASTN D-97
Foaming Tendency, 75° F	1				ASTM D-892
Foam after 5-minute aeration,	1	1			_
ml	1	1	ļ		
Time out, minutes					-
Foam after 10-minute settling,	1				-
ml	1	1			
Neutralization Number, mg KOH/gram	I		1		ASTN D-974
Water Content, 5 by weight	0.010		1		ASTN D-1744
Neutrality, qualitative					Fed. Nethod 5101
Contamination	1	1			
Number and size of particles and	ภี	l			SAE Method ARP-
fibers in 100-ml fluid	!	1			598
25-100 micrometers		1			-
100-500 micrometers	1		1		1 -
over 500 micrometers				1	
particles over 250 microm-	1	1	l		_
eters except fibers (length ten times diameter)			İ		1
Gravimetric Value, mg/100 ml		1	l	İ	SAE Nethod ARP-78
Gravimetric value, mg/100 mi	0.856			l	
Specific gravity, 60/60°F	1 0.000		1		ASTM D-1500
Color Cost \$/gal	\$5.00		ļ		-
Availability	gov. spec	4			
,					

Availability gov. spec.

Determinations made at atmospheric pressure, unless noted.

Supplementary Properties of MIL-P-17111 (1)

		Method
Material Compatibility with	i (¶	See Chapter 2
Buna S	Poor	Test C-3
Natural Pubber	Poor	

*Base on atmospheric pressure data.

MIL-L-17672, MS 2110-TH

Suggested Uses and Possible Limitations

The fluids covered by MIL-L-17672 are petroleum-base fluids which are intended for use as hydraulic fluids and light steam turbine lubricants. The fluid described here is Military Symbol (MS) 2110-TH. Although MIL-L-17672, MS 2110-TH, is used in present-day submarines, its high viscosity eliminates its use in most deep ocean applications.

Properties of MIL-L-17672B, MS2110TH(1)
(Petroleum Base Fluid)

(P	etroleum Ba	se Finia)	*****		
					Method
Viscometric Properties		1000 =	1100		
Viscosity, centistokes, at:	35° F	100° F	150° F		
0 psiq 3,000 psig	338.1	35.68	12.69		See NSRDL
5,000 paiq	628.4	59.23	18.71		Annapolis Report
7,000 paid	984.4	79.88	24.42		MATLAB 350
10,000 psig	1776	125.4	35.15		l '
15,000 psig	2626 68cc(?)	167.0	44.76		-
20,000 psiq	17,400(2)	334.1	80.04		_
10,000 ps g	17,4001-7	660.8	140.9		_
	į		1		
	j				
			ĺ		
	[[
Viscosity, centistokes, at 210° F.	5.35	ĺ	ł		ASTM D-445
- · · · · · · · · · · · · · · · · · · ·	3.25	Ì	}		ASIM Davey
0 psig Viscosity Slope, ASTM	0.771	ł			_
Lubricating Ability	0.112		1%		
4-Ball Wear Test, 30 min, 50° C.	Dry	Dry	Seawater	1% Seawater	Fed. Method 6503
52100 steel, average scar dia.,		Dry	Wet	2/0 0000000	(modified)
mm;	Dry argon	Oxygen	Argon	Wet Oxygen	
5 k g	0.17	****	0.31		_
10 kg	0.24	_	0.38	0.60	_
20 kg	0.27	0.57	0.41	0.64	-
30 kg	0.72	0.62	0.65	0.70	
	1 3.72	1 0.02	0.05	0.70	
	1		1		
	ĺ				
Corrosion Protection	1	{	1		
Stirred Rust Test, 10% seawater,	Pass	ļ	ł		astm D-665
140° F, 2 days		ļ	}		
On-Off Rust Test, 50% seawater,	Fail	İ			See Chapter ?
140° F, 30 days	1	j	1		Test C-5
Ambient Pressure, coupon		i			See Chapter 2
stirred, corrosion test, weight					Test C-1
change, mg	1	!	1		
Copper	-2.7	ŀ			-
Stainless Steel, 316	-0.7	1	1		ļ -
Copper-Nickel (70-30)	-1.7	!	1		
Aluminum, QQ-A-250-4b	+0.1]	1 _
Phosphor-Bronze	-2.1	1	1		
Steel, galvanized	-6.5		1		-
Steel, 1009 Aluminum, QQ-A-250-11	0	i	1	}	_
•	-0.1	!			_
Bronze Monel	-2.0	1	1		_
Monel Silver Base Brazing Alloy	-0.3		l		
20,000 PSIG Pressure-Cycled	-2.1	Ì			See Chapter ?
Corrosion to (1% seawater),	1	1	1		Test C-2
weight change, #9		i			
Insulated Specimens:	1	ļ	ļ		
Copper	1		1		-
Stainless Steel, 316					
Copper-Nickel (70-30)	1	(1	(-
Aluminum, GQ-A-250-4b	1		1	1	-
Phosphor-Bronze	1				-
Steel, galvanized	1			Ì	-
Steel, 1009	1	1			-
Aluminum, QQ-A-250-11			1	1	-
Bronze			1		-
Honel	}	1		1] -
Silver Page Brazing Alloy	1	i	L	L	1 -

				
Correston Brotantian format	1	1	1	Method
Corrosion Protection (Cont)	1	1		1
Electrically Coupled Specimens		1 1		-
Copper-Aluminum, QC-A-P+C-1	t j	1 1	į	1 -
Aluminum QQ-A-C50-46 -	1	1		1 -
Copper-Nickel (70-50)	j	1	i	1
None 1 - Bronze	1	1 1	1	1 -
Stainless Steel (516) -		1 1	1	
Phosphor-Bronze	1	ł /	ĺ	
Silver Base Brazing Alloy -	i		•	1
,	1	1 1		j -
Steel, 1004	į.	! !		
Aluminum Q2-A-250-11 -	1	1 1		! -
Bronze	1	1 1		}
Aluminum QQ-A-250-4b -	i	1 1		1 -
Steel, 1009	i i	1 1		
20,000 PSIG Stirred Corresion	ı	ļ į		See Chapter ?
Test, weight change, mg		1 1		Test C-4
Insulated Specimens:	i	!!!		1686 654
•	1	i ! i		
Copper]]		-
Stainless Steel, 316		1 !		-
Copper-Nickel (70-30)]]]] -
Aluminum, QQ-A-250-4b	1			-
Phosphor-Bronze	1	1 I I		-
Steel, galvanized		1 1		l <u> </u>
Steel, 1000	ſ	1 1		_
Aluminum, QQ-A-250-11]			,
Bronze	ł	1 1		_
	1	1 1		-
None1				-
Silver Base Brazing Alloy		; ; ;		-
Electrically Coupled Specimens:	L.			
Copper-Aluminum, QQ-A-110-11	ł			-
Aluminuma, QQ-A-250-4b -	ł			-
Copper-Nickel (70-30)	!	i i i		
Monel-Bronze	'	i i i		_
Stainless Steel (516) -	i			-
Phosphor-Bronze	ļ	1 1		-
	j			
Silver Base Brazing Allo -				-
Steel, 1009	ł			
Aluminum, QQ-A-250-11 -	ī	1		-
Bronze	:			,
Aluminum, QQ-A-2-0b -	[_
Steel, 1009	i			
Pump Test	ł	1 1		Proposed military
•	1			
Average Weight Loss, mg	1	1 1		specification for
Steel Gears	138			sea-water emuls:-
Bronze Bushings	1480	i i		fying oils
Corrosion Coupons, weight loss,]	, , ,		
each, mg/cm ²				
Copper	0.01		ł	-
Aluminum	1		İ	: _ !
Steel, galvanized	0.05		l	
Steel, 1009	0.01			· _
	0.04	1 1		- [
Silver Base Brazing Alloy	0.02		j	-
Dielectric Properties	1	1 1		ASTH: D-1169 (mod-
Resistivity, 72° F, ohm-cm:		į į		ified). See Chap-
As-Received	4.4×10 ¹²	j 1	ļ	ter 2. Test E-1
With Sea-Water Contamination:		į í	ſ	Chapter 2
0.1∉ by volume	5.4×10 ¹¹	1 1	1	Test E-5
0.5% by volume	,	1 1	1	
2.0% by volume		į j	1	
With Carbon Contamination:(3)	1	1 1	1	
with Carbon Contamination"		i		Chapter 2
0.15 wt/vol.		1 1	ļ	Test E-6
A ACC				
0.25% wt/vol. 0.5% wt/vol.			. 1	- 1

Dielectric Properties (Cont)		Method
After 50,000 Electric Arcs	1 1	See Chapter ?
(makes and breaks) at 90	1 1	Test E-7
volts, 10 amperes, resis-	1 1	1006 E-1
tive load	1 1	
	0 < 11	
Not filtered	8.6x10 ¹¹	-
Filtered	4.2x10 ¹¹] -
Solids generated, gram	1.33	-
Dissipation Factor, 72° F. %		See Chapter :
As-Received	1.0	Test E-?
With Sea-Water Contamination:	0.9	See Chapter ?
0.1% by volume	10.9	· · · · · · · · · · · · · · · · · · ·
0.5% by volume	i I I	- Tent E-5
	1 1 1	\ -
2.0% by volume	1 1	-
With Carbon Contamination:]]]	See Chapter 2
0.10% wt/vol.		Test E-6
0.25% wt/vol.]]) <u> </u>
0.40% wt/vol.		-
After 50,000 Electric Arcs	1 1	1 1
(makes and breaks) at 90		
•	1 1	
volts, 10 amperes, resis-	1 1	1
tive load		
Not filtered	1.6	-
Filtered	1.2	-
		_
Dielectric Breakdown Voltage,		ASTM D-877 (mod
0.05-inch gap, 72° F, kv		ified). See Cha
An received	1,	ter 2. Test E-
With sea-water contamination	15.3	1
with sea-waver contamination?	5.5	See Chapter 2
	1 l	Test E-5
0.5₹ by volume]]	-
2.0≸ by volume		-
With carbon contamination:		See Chapter 2
0.10% wt/vol.		Test E-6
0.25# wt/vol.		1680 1-0
		-
0.50% wt/vol.		j -
After 50,000 electric arcs		
(makes and breaks) at 90		
volts, 10 amperes, resis-		
tive load		
Not filtered	10.7	_
Filtered		
Solids generated, gram	22.1	-
		1
Contact Life, silver-cadmium, 50		See Chapter 2
volts, 10 amperes, resistive	}	Test E-3
load, 6000 psi, 65°-85° F		
Number of tests		-
Operations to failure (range)		
mulsion Stability		
Faddle Test, after 1-hour set-		ASTM D-1401
	1	ASTA D-1401
tling:		
0.1. ml	40	ļ -
Enulsion, ml	0	-
Water, ml	40	_
Electric Proba Text, time for	18	Cer Chapte. 2
water separation, min		Test E-4
aterial Compatibility Static 20KPSP		See Chapter ?
	_	,
Butyl	Poor	Test C-3
Buna N	Good	-
Viton B	Good	-
Ethylene-Propylene	700r	-
Tetrafluoroethylene (Teflon)	Good	-
Neoprene		_
Thickel	Fair	
Silicone	Fair	-
Pluoresilicone	Taux	1 -

			1	1	Method
Volatility					- McCHOO
Toxicity	Petroleum		1		1 -
Density, grams/cubic centimeter, at:	34, F	100° F	1:01		
0 psiq	0.3866	0.8632	0.8468	1	See NSRDL
5,000 psiq	0.8958	0.8735	0.8588		Annapolis Report
5,000 parq	0.9014	0.8796	0.8656		NATLAB 550
8,000 psiq	0.902	0.8879	0.8747		1
10,000 psiq			0.8805	Ì	
	0.9140	0.8935		i	
15,000 psig	0.9213	0.9050	0.8928		
20,000 ps iq	0.9247	0.915/	0.90(1		a supposed the same services are serviced.
Isothermal Compressibility, volume	35° F	100° F	17.0		
decrease, f, at:					See NSRDL
O psig					Annapolis Report
5,000 psig	1.03	1.14	1.40		MATLAB 550
5,000 psig	1.64	1.80	2.17		
8,000 psig	2.48	2.73	5.19		
10,000 paig	3.00	3.29	3.83		
15,000 psiq	4.11	4.53	5.15		
20,000 psig	5.15	5.62	6.31		
Chemical Stability	7				
	1000+				ASTN D-943
hours to failure	1				ASTR D-942
Oxidation Stability Test, 250° F					red, Method 5308
Hydrolytic Stability Test					Military specifie
Specimen change, my	i .				cation N1L-II-
Specimen appearance	l				19457B
luid acid number increase,					-
mg KOH/gram fluid					
Water acidity, mg NOH					_
Insolubles, %	1				_
Thermal Stability Test	1				_
Fire Resistance	i				_
Flash Point, °F	760				hamt n of
	360				ASTN D-92
Fire Point, °F	385				ASTN D-92
Autogeneous Ignition Temperature, F	690				ASTM D-2155
High-Pressure Spray Combustor]				See MEL Report
Minimum spontaneous ignition	453			,	31/66 of Narch
temperature, °F	i I				1967
Minimum reaction temperature,	425				_
°F	- 1				
No indication of fire, "F	425				_
Maximum pressure change, psi	325				_
Lowest temperature of maximum	453				_
pressure change, °F	422	j			_
	105 100 I				
	425-479				-
Miscellaneous Properties					
Pour Point, F	-15				ASTM D-97
Foaming Tendency, 75° F	40				astm d-892
Foam after 5-minute aeration,					-
ml) i	İ		· ·	
Time out, minutes	1 1				 _
Foam after 10-minute settling,	امًا				l <u>-</u>
ml	"				_
Neutralization Number, mg KOH/gram	امما				ASTN D-974
Water Content, % by weight	0.02				ASTM D-1744
	0.015				The state of the s
-	Neutral				Fed. Method 5101
Contamination	j i				-
Number and size of particles and	[į			SAE Nethod ARF-
fibers in 100-ml fluid					598
25-100 micrometers					-
100-500 micrometers					-
over 500 micrometers					_
particles over 250 microm-) i				.
			ļ		
eters except fibers (length	į į		1		
eters except fibers (length		ļ			
ten times diameter)					CRE Workhad ann
ten times diameter) Gravimetric Value, mg/100 ml	0.03				SAE Method ARP- 78
ten times diameter) Gravimetric Value, mg/100 ml Specific gravity at 60/60° F	0.8હ				-
ten times diameter) Gravimetric Value, mg/100 ml Specific gravity at 60/60° F Color	1.5				SAE Method ARP- 78 - ASTM D-1500
ten times diameter) Gravimetric Value, mg/100 ml Specific gravity at 60/60° F	1 (-

Determinations made at atmospheric pressure, unless noted. Extrapolated value. Saturated with seawater.

Supplementary of Properties of MIL-L-17672B, MS 2110TH(1) (Petroleum Base Fluid)

		<u>`</u>	
			Method
ļ	Material Compatibility with:		See Chapter 2
			Test C-3
1	Bune S	Poor	
	Natural Rubber	Poor	
	Polyurethane	good	
i	•		
		L	•

^{*}Based on atmospheric pressure data.

MIL-S-21568A

Suggested Uses and Possible Limitations

The fluid covered by MIL-S-21568A is a 1-cs viscosity dimethyl polysiloxane fluid. MIL-S-21568A has been superseded by Federal Specification VV-D-001078. Since there is no 1-cs viscosity fluid covered by VV-D-001078, the older specification which contains such a fluid had to be used. MIL-S-21568A (1 cs) is considered unsatisfactory for use with motors because of its very low viscosity and poor sea-water emulsion stability. Because of its good dielectric properties, as well as low viscosity, it is the best choice known to date for switching devices and other nonmoving electrical applications.

Properties of MIL-S-21569A(1 CS)⁽¹⁾

(:	ilicone B	se Fluid)	L		
					Method
Viscometric Properties	31.0	1000 0			
Viscosity, contistokes, at: O psig	35° F	100° F	170° F]
5,000 psiq	1.19 2.19	0.76	0.44		See NSRDL
1,000 parq	2.95	1.25	0.83		Annapolis Repert
8,000 psiq	4.29	1.73	1.19		MATLAB 350
10,000 parq	5.11	1.97	1.31		[-
16,000 psiq	8.12	2.91	1.77	•	 -
(0,000 psid	11.56	3.92	2.46		- (
	ļ				
		İ			
	ĺ			1	i
	}		}		l l
	ļ		!]
					1
Viscosity, centistokes, at 210° F,	-	_	-		ASIM D-445
0 parg					}
Viscosity Slope, ASTM	0.854				-
Lubricating Ability 4-Ball Wear Test, 30 min, 50° C,	Dry	+ 1% Synt	hetic Seav	ater	Fed. Method 6503
52100 steel, average scar dia.,					(modified)
mm;	<u> </u>				(modified)
1 kg					-
3 kg			1		
5 k g	0.65	-			
15 kg	1.02	-		i	
30 min, 50° C. 52100 steel	0.63	0.39			
60 min, 10° C, 52100 steel	0.70	0.50			
					ŀ
Corrosion Protection					1
Stirred Rust Te.t, 10% seawater,	Fail		İ		ASTM D-665
140° F, 2 days					
On-Off Rust Test, 50% seawater,	Fail				See Chapter 2
140° F, 30 days					Test C-5
Ambient Pressure, coupon		i ,			See Chapter ?
stirred, corrosion test, weight			İ		Test C-l
change, mg Copper					
Stainless Steel, 316			j		
Copper-Nickel (70-30)	_				_
Aluminum, QQ-A-250-4b	_				-
Phosphor-Bronze	-				_
Steel, galvanized	- 1				-
Steel, 1009	-			4	
Aluminum, QQ-A-250-11	-	j			-
Bronze	-	ļ			-
Monel Silver Base Brazing Alloy	-				-
20,000 PSIC Pressure-Cycled	-				See Chapter C
Corrosion Test (1% seawater),				İ	Test C-2
weight change, mg		ļ			
Insulated Specimens:			}		
Copper			,		-
Stainless Steel, 316			1)	-
Copper-Nickel (70-30)					•
Aluminum, QQ-A-250-4b		i		Ì	-
Phosphor-Bronze			1	ļ	_
Steel, galvanized Steel, 1009			ļ	Ì	_
Aluminum, QQ-A-250-11				3	_
Bronze			1		-
Monel		1	!	ľ	-
Silver Base Brazing Alloy				-	-

	··	 -	1	1	1 Method	ļ
Correston Protection (Cont)			1		h	1
Electrically Coupled Specimens:		[-	
Copper =Aluminum, QQ=A=(∵O=11	}	Į	1	j	ļ -	-
Aleminum QQ-A-PhO-4b -	ļ				-	1
Copper-Nickel (70-50)		l l	1			
Monel-Bronze	l		1		-	1
Stainless Steel (516) -	1	ł	}] -	!
Phosphot-Bronze					İ	İ
Silver Base Brazing Alloy -		ļ	1		-	
Steel, 1004			Ĭ			
Aluminum QQ+A-(50-11 -			1	· ·	-	1
Bronze				İ	1	
Aluminum QQ-A-25C-4b =	}	1	1	Į.	-	
Steel, 1009)	j	ļ	}	J	
10,000 PSIG Stirred Corrosion		Ì	}		See Chapter 1	
Test, Weight change, mg				1	Test C-4	l
Insulated Specimens:		ł	}	1	ł	
Copper			}		-	
Stainless Steel, 316 Copper-Nickel (70-30)		l	1	1	-	1
Aluminum, QQ-A-250-4b		ł			j -	
Phosphor-Bronze		ľ		l	}	1
Steel, galvanized		ł	ì	1] -	1
Steel, 1009		l			-	
Aluminum, QQ-A-250-11		ì	ļ		_	İ
Bronze		l	1] -	
Monel	ĺ				_	
Silver Base Brazing Alloy		[1	1		
Electrically Coupled Specimens:		1		i	_	1
Copper-Aluminum, QQ-A-250-11		ĺ			_	
Aluminum, QQ-A-250-4b -		(1	ĺ	l <u>-</u>	
Copper-Nickel (70-30)		İ		}		i
Monel-Bronze		[1		_	1
Stainless Steel (316) -]			-	
Phosphor-Bronze		i ·				
Silver Base Brazing Allo -		<u> </u>			-	
Steel, 1009		{	[i
Aluminum, QQ-A-250-11 -]	j		-	
Bronze						
Aluminum, QQ-A-250-4b -		ĺ			, -	!
Steel, 1009			1			1
Pump Test		1			Proposed military	
Average Weight Loss, mg					specification for	}
Steel Gears	·				sea-water emulsi-	
Bronze Bushings Corrosion Coupons, Weight loss,					fying oils	
each, mg/cm ²		}				
Copper			i		_	
Aluminum			ł		1]	1
Steel, galvanized			ļ		_	
Steel, 1009					_	
Silver Base Brazing Alloy						
Dielectric Properties					ASTM D-1160 (mod-	1
Resistivity, 78° F, ohm cm:	'				ified). See Chap-	
As-Received	2.2x1013				ter 2. Test E-1	[
With Sea-Water Contamination:	2.4x10 ¹³				Chapter 2	1
			!		Test E-5	ļ
0.5% by volume			j !		-	i
2.0% by volume					-	
With Carbon Contamination:]]	Chapter 2	
0.1% wt/vol.			1		Test E-6	
0.25% wt/vol-			1	ļ	-	
0.5% wt/vol.			1		-	1

	T		Method
Dielectric Properties (Cont)			
After 50,000 Blectric Arcs	ļ		See Chapter 2
(makes and breaks) at 90	ĺ	1 1	Test E-7
volts, 10 amperes, resis-		1 1	
tive load	•	1	
Not filtered	1		
Filtered	1		-
Solids generated, gram	1	i i	
Dissipation Factor, 78° P. %	f	1	See Chapter ?
An Back und	2.0	1	Test E-2
With Sea-Water Contamination;	1.5	1	See Chapter 2
•	1	1 1	- Test E-5
0.5% by volume	i		1
2.0% by volume	ſ	1	1 1 - 1
With Carbon Contamination:			See Charter 2
0.10% wt/vol.		1 i	See Chapter 2
0.25% wt/vol.	1		Test E-6
0.50% wt/vol.	i	1 1	
After 50,000 Electric Arcs		1	
(makes and breaks) at 90	1	1 1	
volts, 10 amperes, resis-	1	1 1]]
tive load	I		
Not filtered	1	1	
Filtered	1		"
Solids generated, gram		1	-
Dielectric Breakdown Voltage,	i	1	ASTM D-877 (mod-
0.05-inch gap, 78° F, kv	i	ì	ified). See Chap-
As received	26.2		1 , ,
With sea-water contamination	16.4	1	ter 2. Test E-3
with sea-water contamination;	10.4	1	See Chapter 2
0.5% by volume		1	Test E-5
2.0% by volume	ł	1 1	-
With carbon contamination:	İ		
0.10% wt/vol.		1	See Chapter 2
0.10% wt/vol. 0.25% wt/vol.	1		Test E-6
	ĺ		-
0.50% wt/vol.	ļ		-
After 50,000 electric arcs			
(makes and breaks) at 90	Ì		
volts, 10 amperes, resis-	1	1	1
tive load	Ì	i :	
Not filtered		1 1	}
Filtered	ļ	1	1 - 1
Solids generated, gram	ļ		
Contact Life, silver-cadmium, 50	1		See Chapter 2
volts, 10 amperes, resistive			Test E-8
load, 6000 psi, 65°-85° F	}		
Number of tests	3 000		-
Operations to failure (range)	>1.0,000]]
Emulsion Stability			3000 0 3103
Paddle Test, after 1-hour set-	i		ASTM D-1401
tling:	1 110	1	i
Oil, ml	40		
Emulsion, ml	0		-
Water, ml	40	1	000 00000
Electric Probe Test, time for	0		See Chapter 2
water separation, min	1		Test E-4
Material Compatibility Static 20K PSI	†		See Chapter 2
Butyl	1		Test C-3
Buna N]	1 1	"
Viton B	l	<u> </u>] - }
Ethylene-Propylene	ļ		-
Tetrafluoroethylene (Teflon)	j]] -
Neoprene	!		
Thiokol			-
Silicone	ŀ	1	
Pluorosilicone	<u></u>	<u> </u>	<u> </u>

(وما مدين الله المنظم المالية المنظم المالية المنظم المالية المنظم	· · · · · ·		1		Se Chart
	Volatilit.				†	-
1	Texterit	Silicone				
-	Densit, grams rabbe contineter, at:	36, F	100	11()	Ì	
	0 part	0.8393	0.8009 0.8189	0.7709 0.7916	Ì	Annos Fri Recent
	4,000 pm1 p	0.8545 0.8659	0.8779	0,505		MATLAL
i	. 129 969.	0.8769		0.8177		1
	10,000 ps++	0.8844	0.8516	0.8267	[
	1,000 parq	0.9012	0.8687	0.8447		
	(0,000 pst)	0.9161	0.8840	0.8614		
	Is thermal compressibility, volume	AL F	90° F	140		Sec NSPDL
	decrease, , at:			1		cannot 1 Property
	(1844) 1844 000€	2.21	2.75	3.65		MATLAL "
	. '000 berd .'000 berd	3.55	4.21	5.38		
	8,000 psi i	5.19	6.11	7.56	J	
	10,000 ps1q	5.61	7.17	8.77	}	
	P,000 psig	8.20	91	11.08	ļ	
	(C)(\ 1800)	კ.85	10.93	13.00		
	Ober out Scability Oxidation Stability Test, 20*6 F.					ASTM D= # 1
	hours to factore		(į (
	Oxidation b ability Tost, 1906 F		Ì			Fed. Method ""
	He holytic Stabilety Test		ł	l j	1	Militar pr 1 -
	specimen change, my		1]	Ì	Fig. () MIL-H-
	р с. quet. appearance					1 1/4 · 18
	Pluid acid number increase,		ł	{	į	_
	r + KOH/gram fluid Water acidity, mg KOH		ļ			_
	Insolubles, "					-
	Thermal Stability Test		}	1 1	ĺ	-
	Fire Resistance		ĺ]		
	Flash Point, F	115	ļ	,	į	ASTM D-92
	Fire Point, F	115	1			ASTM D=97
	Autoreneous Ignition Temperature, F High-Pressure Spray Combustor			ł		See MEL Peport
	Minimum spontaneous ignition	}				31/66 of March
	temperature, °F		; 1]]		1007
	Minimum reaction temperature,	[ļ]	į	- ·
	1.		,			
	No indication of fire, °F	l	}	!!		-
	Maximum pressure change, psi Lowest temperature of maximum	}		1		-
	pressure change, °F			i 1		
	Temperature range explored, °F		ľ	ĺ		-
	Miscellaneous Properties)	Ì]		
	Pour Point, F	<-70		}		ASTM D-97
	Foaming Tendency, 75° F	_			ļ	ASTM D-892
	From after 5-minute aeration, ml	0				
	Time out, minutes			{	1	_
	Foam after 10-minute settling,	1)		-
	π.1]		20011 2 011
	Neutralization Number, mg KOH/gram					ASTM D=0774 ASTM D=17744
	Water Content, % by weight	0.026	Ì	1		Fed. Method '101
	Neutrality, qualitative Contamination			\		-
	Number and size of particles and					SAE A thou FRE-
	fibers in 100-ml fluid		1		[598
	25-100 micrometers		į	[-
	100-900 micrometers]				"
	over 500 micrometers					-
	particles over 250 microm- eters except fibers (length	-				
	ten times diameter)	ļ				
	Gravimetric Value, mg/100 mi)	SAF Methed ARP- 785
	Specific gravity at 60/60°F	0.850				
	Color	1.	1	1	(ASTM D-11 CC
	Cost 3/gal	\$35.00	1	}		
	Availability	gov. spe	q.	1	1	L

Availability qov. sped.

Determinations made at atmospheric pressure unless noted. Saturated with seawater.

MIL-L-23699A

Suggested Uses and Possible Limitations

The fluid described in Military Specification MIL-L-23699A is a synthetic-base lubricant which was developed for aircraft turboprop and turboshaft engines. The atmospheric pressure viscosity of MIL-L-23699A leads to the prediction that it would be too viscous for most deep ocean applications. It has poor hydrolytic stability. It does provide some limited corrosion protection. Dielectric properties have not been determined. Before using this fluid, a system designer should consult a list of compatible materials available from the manufacturer.

Properties of MIL-L-23699A (1) (Synthetic Same Fluid)

	(Byntnetic	Base Flu	14)		
					Method
Viscometric Properties Viscosity, centistokes, at:	100	1000 -	1'0° F		
, ,	35° F	100° F	1, 0, k		
0 parg					. Alfabra
3,000 psiq		l		1	e NSRDL
5,000 psig 8,000 psig					mapolis report
10,000 psiq	l I				TLAB 550
15,000 psiq	ì		:	-	
20,000 psig	1			} -	
20,000 psig				-	
	<u>'</u>				
	ļ				
Viscosity, centistokes, at 100° F,	25.67				
Viscosity, centistokes, at 210° F,	5.00			AS	TM D-445
0 psig]				
Viscosity Slope, ASTM	0.702	[[-	
Lubricating Ability					
4-Ball Wear Test, 30 min, 50° C,	1			F. ·	d. Method 👭 🔞
52100 steel, average scar dia.,	[(to	odified)
mm:				`	
1 kg				-	
3 kg				i -	
5 k g	ſ			[-	
1					
Į					
	}			1	
	ł				
ļ	1				
Corrosion Protection	Pass				mu p 665
Stirred Rust Test, 10% seawater,	Fass			AS	TM D-665
140° F, 2 days On-Off Rust Test, 50% scawater,					e Chapter ?
140° F, 30 days	l .			1 26	Test C-5
Ambient Pressure, coupon	i			Se.	e Chapter 2
stirred, corrosion test, weight				36	Test C-1
change, mg					1000 04.
Copper	-0.2			1_	
Stainless Steel, 316	+0.1			_	
Copper-Nickel (70-30)	-0.2			_	
Aluminum, QQ-A-250-4b	+0.5		Í	-	
Phosphor-Bronze	-0.3			-	
Steel, galvanized	-1.5				
Steel, 1009	-186.2			-	i
Aluminum, QQ-A-250-11	+0.2	[[i	-	
Bronze	-0.2			-	
Monel	-0.1			-	
Silver Base Brazing Alloy	-0.2	[[
20,000 PSIG Pressure-Cycled			ļ	Se	e Chapter ?
Corrosion Test (1% seawater),		Ì			Test C-2
weight change, mg	1	ĺ			
Insulated Specimens:			· •		
Copper			 	-	
Stainless Steel, 316			1	+	
Copper-Nickel (70-30)		j l		-	
Aluminum, QQ-A-250-4b]		l	-	
Phosphor-Bronze				-	
Steel, galvanized	ļ		İ	-	
Steel, 1009			.	-	
Aluminum, QQ-A-250-11		į l	ļ	-	
Bronze		ļ		-	
Monel]		ļ	-	
Silver Base Brazing Alloy	<u> </u>	L			

					Y Masked
Corrosion Protection (Cont)		}		ł	Method
Electrically Coupled Specimens:					
Copper-Aluminum, QQ-A-250-11		ł	1		1 -
Aluminum QQ-A-250-4b -		1] -
Copper-Nick+1 (70-30)	ł	1	1	ł	} -
Monel-Bronze		1			
Stainless Steel (516) -		}	1	}	} -
Phosphor-Bronze					ļ -
Silver Base Brazing Alloy -		ļ	ł	ł	1
Steel, 1004	ł	1		}	} "
Aluminum QQ-A-250-11 -					
Bronze	1	1	1		-
Aluminum QQ-A-250-4b -		1			
Steel, 1009	i	Í	1		l -
20,000 PSIG Stirred Corrosion	1	1	1		See Chapter 2
Test, weight change, mg	i	i	i	1	See Chapter 2 Test C-4
Insulated Specimens:		1			1680 004
Copper	1	1	1	ł	ł
Stainless Steel, 316	l			ł	-
Copper-Nickel (70-30)	ł	1	1		l -
Aluminum, QQ-A-250-4b	l				Į -
Phosphor-Bronze	ł	1	}	l	}
Steel, galvanized	1	1			1 [
Steel, 1009	!				l I
Aluminum, QQ-A-250-11	1	1	1	i	1 _
Bronze			İ		_
Monel	í		ĺ	•	
Silver Base Brazing Alloy					i _
Electrically Coupled Specimens:	1	1	1	İ	
Copper-Aluminum, QQ-A-250-11	,				_
Aluminum, QQ-A-250-4b -	ĺ	i	ì	<u>{</u>	· .
Copper-Nickel (70-30)		1	ł		
Monel-Bronze	1	1	1	1	_
Stainless Steel (316) -	l l		Į]	l _
Phosphor-Bronze	i	ł	ľ	Ì	
Silver Base Brazing Alloy -	1	i			_
Steel, 1009	1	i			
Aluminum, QQ-A-250-11 -	İ				ua.
Bronze	1	1			
Aluminum, QQ-A-250-4b -	1	1		[_
Steel, 1009	ŀ		}	ļ	
Pump Test	ĺ			1	Proposed military
Average Weight Loss, mg	1	}			specification for
Steel Gears	1	[[sea-water emulsi-
Bronze Bushings	ı		1		fying oils
Corrosion Coupons, weight loss,	1		[
each, mg/cm ²	l	1			
Copper	1	i	ĺ		~
Aluminum	l	Į	1	i	-
Steel, galvanized	ĺ	1	ĺ	ľ	~
Steel, 1009	ĺ	1	Į		-
Silver Base Brazing Alloy	ĺ	ſ	1		-
Dielectric Properties	l		1		ASTM D-1169 (mod-
Resistivity, F, Ohm-cm:	i	1			ified). See Chao-
As-Received	l	1			ter 2. Test E-1
With Sea-Water Contamination:	j	I	J		Chapter 2
0.1% by volume		1			Test £-5
0.5% by volume	l	}	ļ	,	-
2.0% by volume	i	i			-
With Carbon Contamination:	į]	j i		Chapter 2
0.1% wt/vol.	İ	1	ŀ		Test E-6
0.25% wt/vol.	l	J)		-
0.5% wt/vol.	<u> </u>	L	L		_

Dielectric Properties (Cont)	1	}	İ	Method
After 50,000 Flectric Arcs	1	1	j	
(makes and breaks) at 90	1 1	Ì		See Chapter 2
volts, 10 amperes, resis-	1	l		Test E-7
tive load	1	1	ľ	
Not filtered	i i	į		
Filtered	1	ļ		} -
Solids generated, gram	i i	1		•
Dissipation Factor, °F, %	1	į		
As-Received	1	ļ	1	See Chapter ?
With Sea-Water Cortamination:	1		}	- Test 5-2
	1		į.	See Chapter ?
0.1% by volume]		1	Test E-5
0.5% by volume	1 1)		-
2.0% by volume	}	j	j	-
With Carbon Contamination:	1	1		See Chapter 2
0.10% wt/vol.]]	1		Test E-5
0.0% wt/vol.	1	1		-
0.50% wt/vol.	[[1	j	-
After 50,000 Electric Arcs	1 1	1		1
(makes and breaks) at 90]]	1		j
volts, 10 amperes, resis-		1	1	
tive load		1	į	1
Not Eiltered		1] _
Filtered	}	į		
Solids generated, gram	1		1	-
Dielectric Breakdown Voltage,	į l	1	{	ASTM D-377 (mod
0.05 inch gap, °F, kv	[ified). See Cha
As received	j	1		ter 2. Test E-
With sea-water contamination:	1			See Chapter ?
0.1% by volume		1		
0.5% by volume				Test E-5
2.0% by volume				1 -
With carbon contamination:		1		
0.10% wt/vol.			Ţ Į	See Chapter 2
• • • • • • • • • • • • • • • • • • • •	!			Test E-6
0.25% wt/vol.			Ì	} -
0.50% wt/vol.]			-
After 50,000 electric arcs	ļ	1	i	
(makes and breaks) at 90		į		1
volts, 10 ampere, resis-		1	į	
tive load		ţ		
Not filtered	1	!		-
Filtered				-
Solids generated, gram]			1 -
Contact Life, silver-cadmium, 50	}	•		See Chapter 2
volts, 10 amperes, resistive	[Test E-5
load, 6000 pai 65°-85° P	j (!		1
Number of tests]	Ì		-
Operations to faiture (range)	1	İ		
mulsion Stability		1		
Paddle Test, after 1-hour set-	1	•		ASTM 0~1401
tling:	!	İ	i	
Oil, wel	110		1	
Emulsion, mi	40	;	•	1 -
Water, ml	7	! i		<u> </u>
	40		ļ	Can Chan and
Electric Probe Test, time for	}		1.	See Chap er ?
water separation, min		1		70€E E-4
laterial Compatibility Static 20%PSI	j			See Chapter ?
Butyl	Poor		Į.	Test C-3
Buna N	Fair	1	i L) -
Viton B	Good			1 -
Ethylene-Propylene	Poor		}	-
Tetrafluoroethylene (Teflon)	Good	Ì		-
Neoprene	Poor		1	j -
Thickel	-	i		-
Silicone	Pair		į	-
Fluorosilicone	- 1	ı	ł	

			1	T	Method
Volatility		İ			-
Toxicity	Synthetic	ļ			l -
Density, grams/cubic centimeter, at:	35° E	100" F	10 T	1	1
C psiq				1	See NSIDL
5,000 pstq	İ			1	Annapolis Report
5,000 parq					MATIAB 550
8,000 ps 14	Ţ				1
10,000 ps 14	Ĭ				
15,000 ps iq				1	
20,000 parq					
Isothermal Compressibility, volume	35° F	100 1	150 F		
decrease, C, at:					See NSRDL
0 parq				i	Annapolis Report
5,000 pary					NATEAB 350
5,000 psig					ĺ
8,000 parg					1
10,000 psiq				1	
15,000 psig					1
20,000 psiq					
Chemical Stability					
Oxidation Stability Test, 203° F.				ŀ	ASTN 0-943
hours to failure			!	1	
Oxidation Stability Test, 250° F					Fed. Method 1708
Hydrolytic Stability Test					Military specifi-
Specimen change, mg				İ	cation MIL-H-
Specimen appearance			•		19457Б
Fluid acid number increase.					
me Koll/gram fluid					
Water acidity, mg KOH	1	1			 _
Insolubles, %	1				1]
Thermal Stability Test					
Fire Resistance					_
Flash Point, °F	100				ASTM D-92
Fire Point, °F	490				ASTM D-92
Autogeneous Ignition Temperature, F	550				ASTM D-2155
High-Pressure Spray Combustor					See MEL Report
Minimum spontaneous ignition	į			ł	31/66 of March
temperature, °F				1	1967
Minimum reaction temperature,				1	1961
°F					-
No indication of fire, °F	ì			•]
· · · · · · · · · · · · · · · · · · ·					1 -
Maximum pressure change, psi				İ	-
Lowest temperature of maximum pressure change, °F					-
Temperature range explored, °F				İ	}
Miscellaneous Properties					-
Pour Point. F					ASTM D-97
	<-55				1 2 1
Foaming Tendency, 75° F				1	ASTM D-892
Foam after 5-minute aeration,	<25			1	1 -
ml	1.0				1
Time out, minutes	1/2				-
Foam after 10-minute settling,	0	İ		1	-
ml					l
Neutralization Number, mg KOH/gram					ASTM D-974
Water Content, 5 by weight					ASTM D-1744
Neutrality, qualitative				1	Fed. Method 5101
Contamination				[1
Number and size of particles and	4	1		1	SAE Method ARP-
fibers in 100-ml fluid	1			[598
25-100 micrometers	1	1			-
100-500 micrometers	1			[-
over 500 micrometers	1			1	-
particles over 250 microm-	1			1	-
eters except fibers (length				1	
ten times diameter)	1				ĺ
Gravimetric Value, mg/100 ml	1				SAE Method ARP-78
Specific gravity at 60/60°F	0.978			<u> </u>	ASTM D-1298
Color			1	I .	
	_			i	ASTM D-1500
Cost \$/gal	\$4.70				- ASIM D-1500

Determinations made at atmospheric pressure, unless noted.

Supplementary Properties of MIL-L-23699A (1)

		Method
Managara Campanihitian	٠	See Chapter ?
Material Compatibility wit	nr	Test C-3
Natural Rubber	Poor	
Polyurethane	Poor	
Buna S	Pour	

^{*}Based on atmospheric pressure data.

MIL-4-27601A

Suggested Uses and Possible Limitations

The fluid covered by MIL-H-27601A is a petroleum-base hydraulic fluid developed for use on high-velocity flight vehicles whose hydraulic components may be subjected to high temperatures. MIL-H-27601A is not suggested for any deep ocean applications until more information is available. Its viscosity is somewhat high, and atmospheric pressure corrosion tests indicate that the fluid provides little if any corrosion protection. Its dielectric properties have not been determined.

Properties of NIL-H-27601A(1)

	(Petrole)	um Base Fl	uid)		
		,			Method
Viscometric Properties					
Viscosity, centistokes, at;	35° ₽	100° F	150° F		i
G paig					
3,000 psig 5,000 psig					See NSRDL
8,000 paig					Annapolis Report
10,000 paid					HATLAB 750
15,000 paig					1 _
20,000 psiy					
1					_
					1
i					
i i					į.
					1
Viscosity, centistokes, at 100° F.	15.11				
Viscosity, centistokes, at 210° F,	3.31				ASTM D-445
O psig					İ
Viscosity Slope, ASTM	0.793			L	l <u>-</u>
Lubricating Ability					
4-Ball Wear Test, 30 min, 50° C,					Fed. Method 690?
52100 steel, average scar dia.,					(modified)
mm:					
1 kg					i -
3 kg					-
5 kg					-
		-			4.5
					į
					1
Garante Sundandian					
Stirred Rust Test, 10% seawater,					ASTN D-C65
140° F, 2 days					ASIA DECOS
On-Off Rust Test, 50% scawater,					See Chapter ?
140° F. 30 days				•	Test C-5
Ambient Pressure, coupon					See Chapter 2
stirred, corrosion test, weight					Test C-1
change, mg					1
Copper	- 8.5		i		1_
Stainless Steel, 316	+ 2.3				1 _
Copper-Nickel (70-30)	+ 6.9				_
Aluminum, QQ-A-250-4b	- 251.5				-
Phosphor-Bronze	- 96.6				-
Steel, galvanized	+ 101.7				-
Steel, 1009	-1046.6				-
Aluminum, QQ-A-250-11	+ 117.1				- .
Bronze	- 4.4				-
Monel	+ 1.5				-
Silver Base Brazing Alloy	+ 10.2				ĺ <u>.</u>
20,000 PSIG Pressure-Cycled		ļ			See Chapter ?
Corrosion Test (1% seawater),					Test C-2
weight change, mg	l	,	ļ		•
Insulated Specimens:			j		1
Copper	i	ļ	1		-
Stainless Steel, 316			ļ		<u> </u>
Copper-Nickel (70-30)		•	j		-
Aluminum, QQ-A-250-4 b Phosphor-Bronze					
Steel, galvanized		l			1 -
Steel, 1009					1 -
Aluminum, QQ-A-250-11		l			1 -
Bronze		l			<u>-</u>
Monel		I			-
Silver Base Brazing Alloy				*	1 _
					

		Method
Corrosion Protection (Cont)		
Electrically Coupled Specimens:]]	-
Copper_Aluminum, QQ_A_250_11 Aluminum QQ_A_250_4b =		-
Copper-Nickel (70-30)		-
Monel-Bronze	1	}
Stainless Steel (516) -	1	
Phosphor-Bronze	1 1	1 1
Silver Base Brazing Alloy -	1 1	1 1_
Steel, 1004		
Aluminum QQ-A-250-11 -	1 1	1 1-
Bronze	1 1	
Aluminum QQ-A-250-4b -	{ 1	{
Steel, 1009	i i	
20,000 PSIG Stirred Corrosion		See Chapter 2
Test, weight change, mg	1 1	Test C-4
Insulated Specimens:	1 1	
Copper	f [1 -
Stainless Steel, 316	ſ	-
Copper-Nickel (70-30)	l i	-
Aluminum, QQ-A-250-4b	ſ	-
Phosphor-Bronze	} }	-
Steel, galvanized	i l	-
Steel, 1009	[[-
Aluminum, Q2 A-250-11	j j	-
Bronze		-
Monel	1 1	} -
Silver Base Brazing Alloy		-
Electrically Coupled Specimens:	1 1	
Copper-Aluminum, QQ-A-250-11	l i	} -
Aluminum, QQ-A-250-4b -		-
Copper-Nickel (70-30)	j j	
Monel-Bronze	i i	-
Stainless Steel (316) -	1 1	-
Phosphor-Bronze		1
Silver Base Brazing Alloy -	Į į	1 -
Steel, 1009 Aluminum, QQ-A-250-11 -		
Bronze	l j	-
	!	
Aluminum, QQ-A-250-4b - Steel, 1009		-
Pump Test		Proposed military
Average Weigh's Loss, mg		specification for
Steel Gears		sea-water emulsi-
Bronze Bushings		fying oils
Corrosion Coupons, weight loss,		7,29 5225
each, mg/cm ²		
Copper		-
Aluminum		-
Steel, galvanized		
Steel, 1009		-
Silver Base E Ezing Alloy	ĺ	_
Dielectric Properties		ASTM D-1169 (mod-
Resistivity, F, ohm-cm:		ified). See Chap-
As-Received		ter 2 Test E-1
With Sea-Water Contamination:		Chapter 2
0.1% by volume		Test E-5
0.5% by volume		
2.0% by volume		-
With Carbon Contamination:		Chapter 2
0.1≸ wt/vol.		Test E-6
0.25% wt/vol.		-
0.5% wt/vol.		-

				 _	Method
Dielectric Properties (Cont)		-]	Methon
After 50,000 Electric Arcs		1			Sce Chapter 2
(makes and breaks) at 90		1	1	1	Test E-7
volts, 10 amperes, resis-			[1	
tive load		1	j		
Not filtered	j		1		1 -
Filtered		1			-
Solids generated, gram	1	1	}	1	} -
Dissipation Factor, °F, %		}]	1	See Chapter ?
As-Received		1			Test E-2
With Sea-Water Contamination:	1	j	}	}	Sec Chapter ?
0.1% by volume	1	ļ			Test E-5
0.5% by volume		ŀ			1 -
2.0% by volume With Carbon Contamination:	1	ļ	i	1	1 -
0.10% wt/vol.	1	1			See Chapter 2
0.25% wt/vol.					Test E-C
0.50% wt/vol.	1	ł	}		-
After 50,000 Electric Arcs	1	1	1		-
(makes and breaks) at 90	1				
volts, 10 amperes, resis-	1	ł		1	1
tive load	1	1	1	}	1
Not filtered			1	}	
Filtered	1	1	1		} -
Solids generated, gram		1	}	1	-
Dielectric Breakdown Voltage.		1			3 cmu p 977 / mad
0.05-inch gap, °F, kv	1	1	1	1	ASTM D-877 (mod-
as received		1	1	1	ified). See Chap- ter 2. Test E-3
With sea-water contamination:	1		l l		See Chapter 2
0.1% by volume	İ	1	1	1	Test E-5
0.5% by volume	1	İ	1		l _
2.0% by volume	1	1			[
With carbon contamination:	1	1	1		See Chapter 2
0.10% wt/vol.	1	ĺ		İ	Test E-6
0.25% wt/vol.	1	-			1000 000
0.50% wt/vol.			1	į	1 - 1
After 50,000 electric arcs	1			1	
(makes and breaks) at 90	ſ	į	İ		
volts, 10 amperes, resis-	1]	ļ	J J
tive load	Į	'			
Not filtered	ĺ			[1 -
Filtered	}	1	1		-
Solids generated, gram	j	1			j -
Contact Life, silver-cadmium, 50			1	i	See Chapter 2
volts, 10 amperes, resistive	}	1	1	ļ	Test E-3
load, 6000 psi, 65°-85° F]		}	ļ	j
Number of tests		1	1	1	1 - 1
Operations to failure (range)	1	1	1	1	1
Enulsion Stability	ļ	1	Į.		
Paddle Test, after 1-hour set-		ĺ			ASTM D-1401
tling:	3	ļ	ļ	!	
Oil, ml	40	}	ŀ	ł	-
Emulsion, ml	0				-
Water, ml	40	}		İ	3 3
Electric Probe Test, time for		}	j		See Chapter ?
water separation, min Material Compatibility, Static 20K PSI	*				Test E-4
Buty1	4		1	}	See Chapter ?
Buna N	Poor	1	1		Test C-3
Viton B	Good	1	1	ĺ	-
Ethylene-Fropylene	Good	1			-
Tetrafluoroethylene (Teflon)	Poor Good	}	1		-
Neoprene	Fair	i			
Thiokol	rair -				<u> </u>
Silicone	Fair		[<u>-</u>
Fluorosilicone	Fair	1	[

	T	Т	1	T	Nethod
Volatility					-
Toxicity	Petroleu				
Density, grams/cubic centimeter, at: 0 psiq	35° r	100° F	150° F	ł	See NSRDL
5,000 psig		ł			Annapolis Report
5,000 psig					NATLAB 350
8,000 paig]				101.12.5
10,000 paig	ŀ	1			
15,000 psig			İ		
20,000 psig				<u> </u>	
Isothermal Compressibility, volume	35° F	100° F	150° F		
decrease, %, at:					See NSRDL
3,000 psiq					Annapolis Report
5.000 paig				 	MATLAB 350
8,000 paig					
10,000 paig					
15,000 paig					
20,000 psig		İ.,			
Chemical Stability					
Oxidation Stability Test, 203° F,		Į			ASTM D-943
hours to failure		1			
Oxidation Stability Test, 250° F			•		Fed. Method 5308
Hydrolytic Stability Test Specimen change, mg		۱			Military specifi-
Specimen change, mg Specimen appearance		0.01 Satisfact	L		cation MIL-H- 19457B
Fluid acid number increase,		0.02	pry		1945/8
mg NOH/gram fluid		0.02			
Water acidity, my KOH		0.41			_ `
Insolubles, \$		Nil			-
Thermal Stability Test					-
Fire Resistance		1			
Flash Point, F	390				ASTM D-92
Fire Point, 7	420				ASTM D-92
Autogeneous Ignition Temperature, P					ASTM D-2155
High-Pressure Spray Combustor Minimum spontaneous ignition	ł				See MEL Report 51/66 of March
temperature, °F					1967
Minimum reaction temperature,	ł				-
*F	İ				
No indication of fire, °F					-
Maximum pressure change, psi	j				-
Lowest temperature of maximum					-
pressure change, F		i			
Temperature range explored, *F					-
Miscellaneous Properties Pour Point, F	<-65				3079 D 07
Foaming Tendency, 75° F	(-02)				ASTM D-97 ASTM D-892
Foam after 5-minute aeration,					- no in D-076
ml					
Time out, minutes			i		-
Foam after 10-minute setting,		İ			-
ml					
Neutralization Number, mg KOH, gram		İ			ASTM D-974
Water Content, % by weight	0.007				ASTM D-1744
Neutrality, qualitative Contamination					Fed. Method 5101
Number and size of particles and					CIP Weshed ann
fibers in 100-ml fluid					SAE Method ARP- 598
25-100 micrometers					<i>J</i> 5∨
100-500 micrometers					_
over 500 micrometers					_
particles over 250 microm-				·	<u>-</u>
eters except fibers (length					
ten times diameter)					
Gravimetric Value, mg/100 ml	0.844				SAE Method ARP- 785
Specific gravity at 70/60°F Color	U.044				ASTM D-1298
Cost \$/gal	\$65.00				ASTM D-1500
Availability	gov, spec	l.			.

Determinations made at atmospheric pressure, unless noted.

Supplementary of Properties of MIL-H-27601A(1)

		Method
Material Compatibility with:	•	See Chapter 2 Test C-5
Buna S	Poor	1000 (-)
Matural Rubber	Poor]
Polyurethane	Good	

Based on atmospheric pressure data.

MIL-H-46004

Suggested Uses and Possible Limitations

The fluid described by MIL-H-46004 is a petroleum-base hydraulic fluid developed for use in missiles where low temperatures are anticipated. The atmospheric pressure viscosity of MIL-H-46004 indicates that it might be satisfactory at a depth capability of 20,000 feet. This fluid provides no corrosion protection, and it is highly flammable. Its lubrication and electrical properties have not been measured.

Properties of MIL-H-46004(1)

••	operties of Petrole	Base Fl			
	[Method
Viscometric Properties Viscomity, centistokes, ut:	31,6	100,	15.0° F		
O parq		1000			
3,000 psig	1				See NSRDL
4,000 parq					Annapolis Report
8,000 psig	[[MATLAB 🏄 🖰
10,000 parq	Í	[-
15,000 pard	1				-
20,000 paid	1				-
	1				
	1	{	l		
					!
	1)		}
			'		
	2.88	1	Į .		
Viscosity, centistokes, at 100° F. Viscosity, centistokes, at 210° F.		l			ASTM D-444
O parq	1.21	[!		
Viscosity Slope, ASTM	0.741		1		
Lubricating Ability					
4-Ball Wear Test, 30 min, 50° C,	1) .)		Fed. Method 603
52100 steel, average scar dia.,					(modified)
mm: 1 kg					<u> </u>
i kg 3 kg			[-
5 k g	1	ĺ	i		1 -
,	1	ł			İ
	1)]		
	1				
		1			1
Corrosion Protection					ASTN: D-EC
Stirrel Rust Test, 10% Seawater,	Fail				ASTN D-CC
140° F, 2 days On=01f Rust Test, 50% seawater,		1			See Charte. 1
140° F, 30 days	1	ł			Test C-5
Ambient Pressure, coupon					See Chapter ?
stirred, corrosion test, weight	1	[Test C-l
change, mg		ľ			
Copper	- 29.2		ļ		-
Stainless Steel, 316	+ 0.6				-
Copper-Nickel (70-30)	- 0.4				-
Aluminum, QQ-A-250-4b Phosphor-Bronze	- 132.7 - 6.8 ⁽²	1		1	-
Steel, 30lvanized	-1194.1				-
Steel, 1009	-1369 •5				-
Aluminum, QQ-A-750-11	- 147.8		1		-
Bronze	- 5-7			}	-
Monel	- 1.5	i			-
Silver Base Brazing Alloy	19.1				See Chariter .
20,000 PSIG Pressure-Cycled Corrosion Tes: (1" snawater),	1				Test C-2
weight change, m;					
Insulated Specimens:					
Copper	1		1		-
Stainless Steel, 316		1			-
Copper=Hinkel (70-30)	[-
Aluminum, QQLA-C+C-4b					-
Phosphor-Bronze	į		1		1
Steel, galvanized					
Steel, 1200 Aluminum, qq.A-000-11	(_
Bronze					-
Monel					=
Silver Fase Brazing Alloy	1	i	l. <u></u>		1122

day Out to the state of the	Met hud
Corrosion Protection (Cont)	
Electrically Coupled Specimens:	-
Copper-Aluminum, QQ-A-250-11	1 1-
Aluminum UQ-A-250-4b -	
Copper-Nicket (70-30)	i
Mone -Bronze	
Stainless Steet (516) -	
Phosphor-Bronze	
Silver Base Brazing Alloy -	
Steel, 1004	
Aluminum QQ-A-250-11 -	!
Bronze	1 1 -
Aluminum QQ-A-250-4b -	i
Steel, 1009	1 •
20,000 PSIG Stirred Corrosion	
Test, weight change, my	See Chapter ?
	Test C-4
Insulated Specimens:	1 1
Copper	1 -
Stainless Steel, 316	1
Copper-Nickel (70-30)	1 -
Aluminum. 00-A-250-4b	[
Phosphor-Bronze	-
Steel, galvanized] _
Steel, 1009	
Aluminum, QQ-A-250-11	
Bronze	j [-
Monel	1 -
Silver Base Brazing Alloy	-
Electrically Coupled Specimens:	-
Copper-Aluminum, QQ-A-250-11	}
	-
Aluminum, QQ-A-250-4b -] -
Copper-Nickel (70-30)	
Monel-Bronze	-
Stainless Steel (516) -	-
Phosphor-Bronze	
Silver Base Brazing Alloy -	-
Steel, 1009	
Aluminum, QQ-A-250-11 -	
Bronze	
Aluminum, 00-A-250-4b -	_
Steel, 1009	1
Pump Test	
Average Weight Loss, mg	Proposed military
Steel Gears	specification for
Bronze Bushings	sea-water emulsi-
	fying oils
Corrosion Coupons, weight loss,	
each, mg/cm²	
Copper	-
Aluminum	-
Steel, galvanized] -
Steel, 1009	-
Silver Base Brazing Alloy	-
nelectric Properties	ASTM D-1169 (mod-
Resistivity, F, ohm-cm:	ified . See Chap-
As-Received	ter 2, Test E-1
With Sea-Water Contamination:	Chapter 2
0.1% by volume	Test E-5
0.5% by volume	lest E-7
2.0% by volume	-
With Carbon Contamination:	-
0.1% wt/vol.	Chapter 2
0.1% Wt/vol. 0.25% wt/vol.	Test E-6
	-
0.5% wt/vol.	,

			,	·	T
Dielectric Properties (Cont)	1	1	1		Method
After 50,000 Electric Arcs	}	1	1		Eng Chanter 3
(makes and breaks) at 90		1	i		See Chapter 2
volts, 10 amperes, resis-	i	1		1	Test E-7
tive load	1				1
Not filtered			1	ŀ	1 _
Filtered			1		1 -
Solids generated, gram		I	!		1 -
Dissipation Factor, *F, A			1		Con Chantar 3
As-Received	l	İ	1	ļ	See Chapter ?
With Sea-Water Contamination:			1		- Test E-2
0.1% by volume	Ţ.	1			See Chapter ?
0.5% by volume	1	1	1		Test E-5
2.0% by volume	ļ		1		
With Carbon Contamination:			1	İ	
0.10% wt/vol.		i	1.		See Chapter 2
					Test E-ú
0.25% wt/vol.		İ	i		j -
0.50% wt/vol.		1	Ī		1 -
After 50,000 Electric Arcs					
(makes and breaks) at 90					
volts, 10 amperes, resis-	l	Į.			1
tive load		İ	1	į.	}
Not filtered					-
Filterea	<u> </u>	1	1		-
Solids generated, gram	l	Į			000
Dielectric Breakdown Voltage,	1	1			ASTM D-877 (mod-
0.05-inch gap, *F, kv					ified). See Chap-
As received	ļ.	ł	1		ter 2. Test E-3
With sea-water contamination:		İ	l		See Chapter 2
0.1≸ by volume					Test E-5
0.5% by volume		ł	İ		-
2.0% by volume	1]	-
With carbon contamination:	1	1			See Chapter 2
0.10% wt/vol.	[l			- Test E-6
0.25% wt/vol.	1	i			-
0.50% wt/vol.		1			-
After 50,000 electric arcs		1			i
(makes and breaks) at 90			ł		1
volts, 10 amperes, resis-		1			1
tive load					
Not filtered		l			-
Filtered		l	1		- .
Solids generated, gram					-
Contact Life, silver-cadmium, 50			[See Chapter 2
volts, 10 amperes, resistive		1			Test E-3
load, 6000 psi, 65°-85° F				l	i
Number of tests		I			-
Operations to failure (range)		ļ	1		
Emulsion Stability		1			
Paddle Test, after 1-hour set-				1	ASTM D-1401
tling:			ĺ		1
Oil, ml	40				-
Emulsion, ml	o	j		İ	_
Water, ml	40	l			l _
Electric Probe Test, time for	'-	l			See Chapter 2
water separation, min		l			Test E-4
'aterial Compatibility Static 20KPSI		ſ	‡		See Chapter 2
Butyl	Poor	l			Test C-3
Buna N	Good	l			_ :::::::::::::::::::::::::::::::::::
Viton B	Good	I			1 _
Ethylene-Propylene	Poor				1 _
Tetrafluoroethylene (Teflon)	Good	1	l		1 =
Neoprene	Fair	1			1 1
Thiokol	Larr				1 2
Silicone	Fair	1			1 2
Fluorosilicone	Fair	l			1 -
		·			

		T		, , , , , , , , , , , , , , , , , , , 	Method
Volatility	1			Ì	-
Toxicity	Petroleus	L			
Density, grams/cubic centimeter, st:	75.	100° F	150° F		
0 paig		[}	See NSRDL Annapolis Report
5,000 paig 5,000 paig	}		{		MATLAB 350
8,000 paig			f .		RATIAB 350
10,000 psig			1		
J5.000 paig					
20.000 paig					
Isothermal Compressibility, volume	35° F	100° F	150° F		
decrease, %, at:					See NSRDL
0 psig					Annapolis Report
3.000 paig	i 1				HATLAB 350
5,000 paig					
8,000 psig					[
10,000 paig					(
15,000 psig					Ì
20,000 paig					
Chemical Stability Oxidation Stability Test, 203° P.					ASTN D-943
hours to failure					
Oxidation Stability Test, 250° P	1				Fed. Method 5308
Hydrolytic Stability Test				i	Nilitary specifi-
Specimen change, mg		:			cation MIL-II-
Specimen appearance					19457В
Fluid acid number increase,					-
mq NOH/gram fluid	}				1
Water acidity, mg NOH	1				} -
Insolubles, \$	1] -
Thermal Stability Test					~
Fire Resistance				•	<u> </u>
Flash Point, F	570				ASTM D-92
Fire Point, *F	550		'		ASTM D-92
Autogeneous Ignition Temperature, T	1 1				ASTM D-2155
High-Pressure Spray Combustor					See MEL Report
Minimum spontaneous ignition temperature, "F	,				1967
Hinimum reaction temperature,	1		{		1301
* P			'		
No indication of fire, 'F					_
Maximum pressure change, psi	}		1		_
Lowest temperature of maximum)		1		} _
pressure change, "F))
Temperature range explored, "F]		Ì		l -
Miscellaneous Properties	i i				
Pour Point, P	<-75		ł		ASTM D-97
Foaming Tendency, 75° F	Į į		Ì	}	ASTH D-892
Foam after 5-minute aeration,	1	}	Ì		-
ml	[}	
Time out, minutes	(-
Foam after 10-minute settling,	[•
Manager States and Market and Market	[}			ASTH D-974
Neutralization Number, mg NOH/gram Water Content, % by weight	j	Ì			ASTM D-974 ASTM D-1744
Neutrality, qualitative	1		'		Fed. Nethod 5101
Contamination		•	'		-
Number and size of particles and	i	1	1		SAE Method ARP-
fibers in 100-ml fluid	}				598
25-100 micrometers	}	1	[.
100-500 micrometers	}				-
over 500 micrometers			ł		-
particles over 250 microm-]	1	Į į		-
eters except fibers (length	}				
ten times diameter)	(ļ		43. No. 43. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
Gravimetric Value, mg/100 ml		{	[SAE Method ARP- 78
Specific gravity at 70/60' P	0.850	1	1		ASTH D-1298
Color	40.00	}			ASTM D-1500
Cost \$/gal	\$2.00	}			-
Availability	IGOV. PDEG	<u> </u>		L	L <u></u>

Availability | Igov. sped.

Determinations made at atmospheric pressure, unless noted. Heavy deposits indicates corrosion not shown by weight change.

Supplementary Properties of MIL-H-46004

		Method
Unterial Compatibility with	1	See Chapter ? Test C-3
Suns S	Poor	
Matural Rubber	Poor	
Polyurethane	Gond	•
	1	i

Based on atmospheric pressure data.

MIL-H-81019B

Suggested Uses and Possible Limitations

The fluid covered by MIL-H-01019B is a petroleum-base hydraulic fluid for use in aircraft, missiles, and ordnance hydraulic systems in the -90° to +210° F temperature range.
MIL-H-81019B appears to have properties for use at great depth. Its viscosity appears to be too low at atmospheric pressure for use as a general-purpose lubricant. It provides some degree of corrosion inhibition, and it is highly flammable. Initial dielectric properties are good, but additional information relating to electrical applications is lacking.

Properties of MIL-H-81019B(1) (Petroleum Base Fluid)

	(Leftore	(Mar Baso F)	luiaj		
	T		I		Method
Viscometric Properties	20.9	100° n			
Viscosity, centistokes, at:	55° F	100° F	15C* F		1
0 paig 5,000 paig	ł	İ	1		See NSKDL
5,000 paig	ŀ				Annapolis Report
8,000 psig		i	}		NATLAB 350
10,000 psig	1	1			-
15,000 psig					-
20,000 psig					-
•					
	1				
	1				}
•					
Viscosity, centistokes, at 100° P,	7.20				
Viscosity, centistokes, at 210° F,					ASTN D-445
0 paig					
Viscosity Slope, ASTM	0.565				
Lubricating Ability					
4-Ball Wear Test, 30 min, 50° C,	į				Fed. Method 6503
52100 steel, average scar dia.,				·	(modified)
mph :				·	
l kg	[<u> </u>
3 kg 5 kg					i
o kg	•] -
•					
•					ł
	į				
Corrosion Protection					30m; 5 665
Stirred Rust Test, 10% seawater, 140° F, 2 days					ASTN D-665
On-Off Rust Test, 50% seawater,	Pass				See Chapter ?
140° F, 30 days					Test C-5
Ambient Pressure, coupon	j				See Chapter ?
stirred, corrosion test, weight	1				Test C-1
change, mg					
Copper	-1.0				l -
Stainless Steel, 316	-0.1				l -
Copper-Nickel (70-30)	-0.5		l		-
Aluminum, QQ-A-250-4b	0				-
Phosphor-Bronze	-0.4				-
Steel, galvanized	-0.3				-
Steel, 1009 Aluminum, QQ-A-250-11	0				-
Aluminum, QQ-A-250-11	ا و ا				.
Monel	-0.5 -0.2			l	
Silver Base Brazing Alloy	-0.4				_
20,000 PSIG Pressure-Cycled	•••				See Chapter 2
Corrosion Test (1% seawater),	1				Test C-2
weight change, mg					1
Insulated Specimens:			i		
Copper			i		-
Stainless Steel, 316]				-
Copper-Nickel (70-30)					-
Aluminum, QQ-A-250-4b	{				-
Phosphor-Bronze Steel, galvanized]			•	_
Steel, 1009					
Aluminum, QQ-A-250-11]				-
Bronze					•
None1]		.5		-
Silver Base Brazing Alloy					

	1	T	1	7	Method
Corresion Protection (Cont)	1				
Electrically Coupled Specimens:		1		Ì	i -
Copper-Aluminum, QQ-A-250-1	l.	}	1		-
Aluminum QQ-A-250-4b -	j.	}	1	j] -
Copper-Mickel (70-30)		}	1		
Monel-Bronze	1	1	Į.	İ	-
Stainless Steel (316) -	1	ì]	ļ] -
Phosphor-Bronze	İ	1	1		1
Silver Dame Brazing Alloy -	I	1	•		-
Steel, 1004	l	[1		
Aluminum QQ-A-250-11 -	1	1	j		-
Bronze	i	J	}		ļ
Aluminum 90-A-250-4b -	i	1	1		-
Steel, 1009	[1	ĺ	[
20,000 P#IG Stirred Corrusion	1	i	1	İ	See Chapter 2
Test, weight change, mg			1		Tort C-4
Insulated Specimens:	İ	j			
Copper	1	!	i		-
Stainless Steal, 316	1	ł	ĺ	l	_
Copper-Nickel (70-30)	i	ł	1		-
Aluminum, QQ-A-250-4b	1	1	i	1	l <u>-</u>
Phosphor-Bronze	1	1	ĺ	1	1 -
Stcel, galvenised		1	1		-
Steel, 1009	1	ļ	· ·		_
Aluminum, QQ-A-250-11		ł	!	1	_
Bronse	1	!	1	Ì	_
Konel	1	}		-	_
Silver Base Brazing Alloy	!	ļ	i		_
Electrically Coupled Specimens:	. l	Ì		İ	
Copper-Aluminum, 00-A-250-11		1	1		
	`		!		_
Aluminum, QQ-K-250-4b - Copper-Mickel (70-30)		1			_
Monel-Brenze	ļ	İ		1	_
Stainless Steel (316) -	1	1	1		_
Phusphor-Bronze	i		1		
Silver Base Brading Alloy -	1				_
Steel, 1009	1				-
Aluminum, QQ-A-250-11 -		1	1		_
Bronse	i	l	1		-
Aluminum, 00-1-250-4b	1			İ	i -
Steel, 1005		1	1		
Fump Test		İ	1		Proposed military
Average Paight Loss, mg	}	1	1		specification for
Steel Gears	i		i		secureation for sea-water emulsi-
Sronze Bushings		1			fying oils
Sorrosion Coupons, weight loss,		1	1		tyrng orrs
^*	'	1	1		
each, mg/cm²	Ì	1	1		
Copper	i	1			-
Aluminum	1	1			-
Danel malimateral		1	1		-
Steel, galvanized			1		
Steel, 1009					-
Steal, 1009 Silver Base Brazing Alloy		Taking managaran da kanagaran		-	
Steel, 1009 Silver Base Brazing Alloy Dielectric Properties	11				
Steel, 1009 Silver Base Brazing Alloy Dielectric Properties Resistivity, 75° P, ohm-cm:	2.5x10 ¹¹				ified). See Chap-
Steel, 1009 Silver Base Brazing Alloy Dielectric Properties Resistivity, 75° P, ohm-cm: As-Rescived	2.6×10 ¹¹		,		ified). See Chap- ter 2. Test E-1
Steel, 1009 Silver Base Brazing Alloy Dielectric Properties Resistivity, 75° P, ohm-cm: As-Rescived With Ses-Mater Contamination:	2.6×10 ¹¹		The state of the s		ified). See Chap- ter 2. Test E-1 Chapter 2
Steel, 1009 Silver Base Brazing Alloy Dielectric Properties Resistivity, 75° P. ohm-cm: As-Received With See-Water Contamination: 0.1% by volume	2.5×10 ¹¹		The state of the s		ified). See Chap- ter 2. Test E-1
Steel, 1009 Silver Base Brazing Alloy Dielectric Properties Resistivity, 75° P, ohm-cm: As-Rescrived With See-Mater Contamination: 0.19 by volume 0.5% by volume	2.5×10 ¹¹				ified). See Chap- ter 2. Test E-1 Chapter 2
Steel, 1009 Silver Base Brazing Alloy Dielectric Properties Rasistivity, 75° P, ohm-cm: As-Raccived With Ser-Mater Contamination: 0.1% by volume 0.5% by volume 2.0% by volume	2.5×10				ified). See Chap- ter 2. Test E-1 Chapter 2 Test E-5
Steal, 1009 Silver Base Brazing Alloy Dielectric Properties Resistivity, 75° F, ohm-cm: As-Bactived With Ses-Matter Contamination: 0.1% by volume 0.5% by volume 2.0% by volume With Tarbon Contamination:	2.5×10 ¹¹		Vanish of the state of the stat		Chapter 2 Test E-5 Chapter 2
Steel, 1009 Silver Base Brazing Alloy Dielectric Eroperties Resistivity, 75° F, ohm-cm: As-Remctived With Ses-Mater Contamination: 0.1% by volume 0.5% by volume 2.0% by volume With Tarbon Contamination: 0.1% wt/vol.	2.6x10 ¹¹				ified). See Chap- ter 2. Test E-1 Chapter 2 Test E-5
Steel, 1009 Silver Base Brazing Alloy Dielectric Evocetties Resistivity, 75° F, ohm-cm: As-Rectived With Ser-Mater Contamination: O.1% by volume O.5% by volume 2.0% by volume With Carbon Contamination:	2.6x10 ¹¹				ified). See Chapter 2. Test E-1 Chapter 2 Test E-5

		T	1	<u> </u>	Method
Dieloctric Properties (Cont)	l		1	Į	
After 50,000 Electric Arcs					See Chapter ?
(makes and breaks) at 90	l	1	}		Test E-7
volts, 10 amperes, resis-		1			
tive load			1	1	
Not filtered		l		1	-
Filtered	ĺ				-
Solids generated, gram			1.		-
Dissipation Factor, 76 °F, &		ļ			See Chapter ?
As-Received	1.3	1		*	Test E-2
With Sea-Water Contamination;		ŀ	!		See Chapter 2
0.1% by volume		1	1		Test E-5
0.5% by volume					-
2.0% by volume			ł	1	-
With Carbon Contamination:		1	1	•	See Chapter ?
0.10% wt/vol.		1	Į.		Test E-6
0.25% wt/vol.		i			! -
0.50% wt/vol.		ł			i -
After 50,000 Electric Arcs		ł			i
(makes and breaks) at 90		l			1
volts, 10 amperes, resis-		1	į		
tive load		1		ŀ	ì
Not filtered		1			-
Filtered					-
Solids generated, gram		1		1	
Dielectric Breakdown Voltage,]			ASTM D-877 (mod-
0.05-inch gap, 76 °F kv		i	1		ified). See Chap-
As received	22.4	i	1	ŀ	ter 2. Test E-3
With sea-water contamination:			1	ł	See Chapter 2
0.1≸ by volume		j	1		Test E-5
0.5% by volume		į			-
2.0% by volume		ł	İ	ļ	-
With carbon contamination:		i	ŀ		See Chapter 2
0.10% wt/vol.		1			Test E-6
0.25% wt/vol.		1	1		-
0.50% wt/vol.		į	1]	-
After 50,000 electric arcs	ŀ	İ	İ		
(makes and breaks) at 90		į		·	İ
volts, 10 amperes, resis-	Ì	1	ŀ		1
tive load			Ì		
Not filtered] -
Filtered	į				-
Solids generated, gram					-
Contact Life, silver-cadmium, 50		ŀ			See Chapter 2
volts, 10 amperes, resistive		1]	1	Test E-8
load, 6000 psi, 65°-85° F	l]			1
Number of tests	1	1]		i -
Operations to failure (range)	1	I			
Emulsion Stability		I			3000 D 3803
Paddle Test, after 1-hour set-		l	Į		ASTN D-1401
tling		1	1		i
Gil, ml	28	İ		İ	-
Emulsion, ml	48				-
Water, ml	4				-
Electric Probe Test, time for			1		See Chapter 2
water separation, min		1			Test E-4
Material Compatibility Static 20KPSI		i	1		See Chapter 2
Butyl	Poor	1	1		Test C-3
Buna N	Good	1			-
Viton B	food.	1	!		-
Ethylene-Propylene	Poor	1	1		-
Tetrafluoroethylene (Teflon)	Good	1	I		-
Neoprene	Fair		1		•
Thiokol		i			-
Silicone	Fair	1	[-
Fluorosilicone	Fair	i .	l l		-

^{*} Based on atmospheric pressure data.

			· · · · · · · · · · · · · · · · · · ·	·	~~~
Volatility	1	1	[Method
Toxicity	Petrole				-
Density, grams/cubic centimeter, at:	35 F	100° F	170	 	
O psig	122-	100 7	150° F	ł	
5,000 psig	i	1			See NSRDL
5,000 paig		ì	l	J	Annapolis Report
8,000 psig			l	İ	MATLAB 350
10,000 psig		1	1		
15,000 paig	I			l	1
20,000 paig	1		ł	ļ	
Isothermal Compressibility, volume	35° F	100° F	150° F		
decrease, %, at:		 			See NSRDL
0 psig	1	1			Annapolis Report
3,000 paig	1				NATLAB 350
5,000 psig	1	1 .			14 >>*
8,000 psig	1				
10,000 paig					
15,000 paig	1				
20,000 psig	<u> </u>				
Chemical Stability					
Oxidation Stability Test, 203° F,					ASTN D-943
hours to failure	İ				
Oxidation Stability Test, 250° F					Fed. Method 5308
Hydrolytic Stability Test					Military specifi-
Specimen change, mg		1			cation MIL-H-
Specimen appearance					19457в
Fluid acid number increase,		1			-
mg NOH/gram fluid					
Water acidity, mg NOH	ŀ	1			-
Insolubles, %					-
Thermal Stability Test					-
Fire Resistance		1			
Flash Point, P	575				ASTN D-92
Pire Point, *F	225			•	ASTM D-92
Autogeneous Ignition Temperature, F	Ί.				ASTN D-2155
High-Pressure Spray Combustor					See MEL Report
Minimum spontaneous ignition	1				51/66 of March
temperature, °F	1	1 1			1967
Minimum reaction temperature, *F	Ì				-
No indication of fire, *F	1	i i			
Maximum pressure change, psi	1	}			-
Lowest temperature of maximum	l	1 1			-
pressure change, "F	l				-
Temperature range explored, "F	1	1			!
Miscellaneous Properties					-
Pour Point. P					
Foaming Tendency, 75° F	<-90	1			ASTM D-97
Foam after 5-minute aeration,		1			astm d=892
ml	1		ŀ		·
Time out, minutes	1	1	l		
Foam after 10-minute settling,	1	i	4		-
ml	1	1 1	1		-
Neutralization Number, mg NOH/gram			Ī		3.0ms p. 0775
Water Content, % by weight	1		j		ASTM D-974
Neutrality, qualitative	1		ļ		ASTM D-1744
Contamination	i		ĺ		Fed. Method 5101
Number and size of particles and	d	[[l		SAE Method ARP-
fibers in 100-ml fluid					598
25-100 micrometers	1				
100-500 micrometers	1	ĺ			_
over 500 micrometers		İ	1		1
particles over 250 microm-					
eters except fibers (length		į į	į		-
ten times diameter)			I		1
Gravimetric Value, mg/100 ml			Į.		SAE Method ARP-785
Specific Gravity at 70/60 °F	0.858		ľ		ASTM D-1298
Color					ASTM D-1500
Cost \$/gal	Available	from supp	lier	l	-
	gov. spec		٠.		_

Determinations made at atmospheric pressure, unless noted.

Supplementary of Properties of MIL-H-81019B(1

		Method
Material Compatibility wit	h i¶	See Chapter ?
Brine 8	Poor	Test C.3
Matural Rubber	Poor	
Polyurethane	Good	

^{*} Based on atmospheric pressure data.

PROPRIETARY FLUIDS

Fluid Code A

Suggested Uses and Possible Limitations

Fluid Code A, a sea-water emulsifying hydraulic fluid, Grade 1, petroleum-base oil, has the same viscosity as MIL-L-17672, MS 2110-TH, which is too high for most deep ocean applications. It has good lubricating properties and good corrosion-inhibiting properties. Its dielectric properties are questionable for deep ocean applications in that it has a low resistivity and a high dissipation factor.

Fluid Code A⁽¹⁾
(Petroleum Base Fluid)

		(Petroleu	m Base Flu	11d)	
					Method
Viscometric Properties	l	[ļ	i	
Viscosity, centistokes, at:	55° F	100° F	150° F	İ	1
C psig				1)
5,000 psiq	İ	ľ		1	Ser NSRDL
5,000 parq	1	Í	1	1	Annapolis Report
1		1	1		
8,000 pany	1	1	İ		MATLAB 350
10,000 parq		,			· -
15,000 psig	i	ĺ	Į		-
10,000 bard	ĺ	j			-
•	ł	l		1	(
	l				i
	}	Ĭ			
		ļ	ļ		[
]	}			
	1				
]				
Viscosity, centistokes, at 100°F,	41.9				
Viscosity, centistokes, at 210° F,		1			ASTM D-441
0 psiy	}	i			
	0.00			ļ	
Viscosity Slope, ASTM	0.768				
Lubricating Ability	ł	l	1.4		
4-Eall Wear Test, 30 min, 50° C,	Dry	Dry	Seawater	16 Seawater	red. Method 6503
52100 steel, average scar dia.,		Dry	T		(modified)
mm:	Dry Argon		Wet Argon	Wet Oxygen	,
	0.16	/wideii	0.36	wer oxyden	i
5 kg					-
10 kg	0.26	0.24	0.38	0.48	-
20 kg	0.29	-	0.41	0.50	-
30 kg	0.34	0.32	0.43	0.66	
, ,	1				
	ļ	l		į	
	İ				
	i	!	\	1	1
	!			` }	
	1	1		i	1
Corrosion Protection					1
Stirred Rust Test, 105 seawater,	Pass	}			ASTN: 0-665
140° F. 2 days	1	}	}	ŀ	1 10 11 2 200
		Į			Can Chausan C
On-Off Rust Test, 50% seawater,	Pass	ļ			See Chapter ?
140° F. 30 days	i				Test C-5
Ambient Pressure, coupon		1		İ	See Chapter ?
stirred, corrosion test, weight	ì	ì		ì	Test C-1
change, mq					
	-69.5	ľ		1	1
Cupper			1		· -
Stainless Steel, 316	- 0.2	ĺ			-
Copper-Nickel (70-30)	- 0.1	l	[<u> </u>
Aluminum, QQ-A-250-4b	+ 0.1	l	ł		-
Phosphor-Bronze	- 1.0	ì			1 -
Steel, galvanized	- 2.6	l			l -
Steel, 1009	+ 0.1	1]		1 _
Aluminum, QQ-A-250-11		l			•
	+ 3.1	l	l	l	-
Bronze	- 1.2	1		!	-
Monel	- 0.3	Į		1	-
Silver Base Brazing Alloy	-72.4	[
20,000 PSIG Pressure-Cycled	1	Į.			See Chapter 2
Corrosion Test (1% seawater),		1			Test C-2
	1	ł			1635 6-6
weight change, mg	(l	l i	i	
Insulated Specimens:	1	[]	1
Copper	1)			1 -
Stainless Steel, 316	Í				J -
Copper-Nickel (70-30)	ì	·		}	1 _
,	1	1			1
Aluminum, QQ-A-250-4b	l	l			j -
Phosphor-Bronze	ļ	Į.			-
Steel, galvanized	1				-
Steel, 1009	1	Ì	İ] -
Aluminum, QQ-A-250-11	l				_
Bronze	1)			1 _
ł	1	}			, -
Monel	ı				-
Silver Base Brazing Alloy	L	L	L	L	<u> </u>

					He thod
Corresion Protection (Cont)			1		METHOD:
Electrically Coupled Specimens:	l	1			
Copper-Aluminum, QQ-A-250-11	ĺ				-
Aluminum 20-A-250-4b -	ļ	j	j	j	j -
Copper-Nickel (70-50)	1		İ		ŀ
Hone 1 - Bronze	1		}		1 -
Stainless Steel (516) -	1	1	1		-
Phosphor-Bronze		1	1		
Silver Base Brazing Alloy -		1	1	l I	1 -
Steel, 1004	ł		1		
Aluminum UU-A-250-11 - Bronse	ł	1	1		1 -
Aluminum QQ-A-250-4b -	ŀ	1	}		
Steel, 1009		1	1		1 -
20,000 PSig Stirred Corresion					See Chapter ?
Test, weight change, my		1	1		Test C-4
Insulated Specimens:					
Ссерет		İ	,		1 -
Stainless Steel, 516		1			! -
Copper-Mickel (70-30)					-
Aluminum, QQ-A-250-45		İ	1		! -
Phosphor-Bronze			1		-
Steel, galvanised		j]		-
Steel, 1009		ł			-
Aluminum, QQ-A-250-11			1		ļ -
Bronze		1			-
Nonel		}	1 1		-
Silver Base Brazing Alloy Electrically Coupled Specimens:		1			-
Copper-Aluminum, QQ-A-250-11		1	1		_
Aluminum, QQ-A-250-4b -		1	ļ		
Copper-Nickel (70-30)		Į.			
Monel-Bronze		1			_
Stainless Steel (516) -		{			_
Phosphor-Bronze					
Silver Base Brazing Alloy -		1			-
Steel, 1009		j	j		
Aluminum, QQ-A-250-11 -			1 1		-
******	1	l			
Aluminum, QQ-A-250-4b -					-
Steel, 1009 Pump Test		Į	1 1		Proposed military
Average Weight Loss, mg]		specification for
Steel Gears	-	İ	1 1		sea-water emulsi-
Bronze Bushings	3	ļ			fying cils
Corrosion Coupons, weight loss,	_	1	1 1		
each, mg/cm ²	_		1		
Copper	0.40	1	[[-
Aluminum	0.01				-
Steel, galvanized	0.02	1]]		-
Steel, 1009	0.01]		-
Silver Rame Brazing Alloy	0.51	ļ	}		-
Dielectric Properties		•	İ		ASTH D-1164 (mod-
Resistivity, 77 F, Ohm-Cm:		İ	1		ified). See Chap-
As-Received With Sea-Water Contamination:	7.4×10 ⁹]		ter 2. Test E-1
0.1% by volume			1	l	Chapter 2 Test E=C
0.5% by volume			1		1 W B L C
2.0% by volume					-
With Carbon Contamination:		ļ]	1	Chapter 2
0.1% wt/vol.					Test E-6
0.25% wt/vol.			!		-
0,' ≸ #t/vol.			[[-

			Method
Dielectric Properties (Cont)			716 CHOO
After 0,000 Electric Arcs			See Chapter ?
(makes and breaks) at 90	[Test E-7
volts, 10 amperes, resis-			
tive load	1	} }	
Not filtered	j		-
Filtered			
Solids generated, gran Dissipation Factor, 77 °F, 4			
As-Received	1		See Chapter 1
With Sea-Water Contamination:	. 0.0		Test E-1
0.1% by volume			See Chapter ?
0.5≸ by volume			Test E-5
2.0% by volume	1		1 -
With Carbon Contamination:			See Chapter 2
0.10f wt/vol.			Test E-6
0.25# wt/vol.		i	-
0.50€ wt/vol.			-
After '0,000 Electric Arcs	1 1		
(makes and breaks) at 90		i]
volts, 10 amperes, resis-	1		
tive load] [į
Not filtered Filtered			~
Solids generated, gram			-
Dielectric Breakdown Voltage,	1		1 S C T 1 S C
0.05-inch gap, 77 °F, kv	1 1		ASTM D-877 (mod- ified). See Chap-
As received	21.6		ter 2. T. ac E-3
With sea-wai r contamination:	1		See Chater ?
0 ≸ by volume			Test E-5
0. ₹ by volume			
2.0% by volume			[-
With carbon contamination:			See Chapter 2
0.10% wt/vol.			Test E-€
0.254 wt/vol.			
0.50% wt/vol. After 50,000 electric arca			-
(makes and breaks) at 90	1		
volts, 10 amperes, resis~			
tive load			[
Not filtered	1 1		_
Filtered		į į	_
Solids generated, gram	1		-
Contact Life, silver-cadmium, 50	1		See Chapter ?
volts, 10 amperes, resistive	1		Test E-3
load, 6000 ps:, 65°-85° r	1		
Number of tests			-
Operations to failure (range) Emulsion Stability			
Paddle Test, after 1-hour set-			ASTM D-1401
tling:	1		NOTE DOING
Oil, ml	0		_
Emulsion, ml	80		-
Water, ml	0		- :
wheat is Probe Test, time for			See Chapte: [
water separation, min			Test E-4
Material Compatibility Static 20KPSI			See Chapter :
Butyl	Poor		Test C-3
Buna M	Good		-
Viton B	Good		-
Ethylene-Propylene Tetrafluoroethylene (Teflon)	Poor		•
Menorene	Good		-
Thinkel	Pair		
5:l:cor*	Fair		•
	1 - 1	1	

Fluorosilicone
* Based on atmospheric pressure data.

	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	·····	· · · · · · · · · · · · · · · · · · ·	Sethel
Volatility					-
Toxicity	Petroleu	d			I
pensity, grams/cubic centimeter, atr	31,7 1	100 F	1101		
C bard				l	serie febilitat
1,000 Faid]			Annapolice recess?
1,000 (ast)	ł	}	ļ		EATIAN "
8,000 parq	1	j	1	l	
10,000 parq			i	1	
15,000 ps.q 20,000 ps.q					
Isothermal Compressibility, volume	352-1	1. 1994. 1	71.6*77		
decrease, t, at:		 			nee Solible
Opsid					Annapolas ierost
5,000 para					MATLAB 155
5,000 parq		i			
8,000 parq		Ì			
10,000 paid		}	1		
15,000 p#14	İ		i		*
20,000 psig		ļ	<u> </u>		
Chemical Stability					ASIN D-945
Oxidation Stability Test, 203° F,	525		i		ASIR DEST
hours to failure Oxidation Stability Test, 250° F		•	!		Fed. Method 570
Hydrolytic Stability Test					Military specifie
Specimen change, mg					cation KlL-II-
Specimen appearance					19457в
Fluid acid number increase,		!	İ		-
mg KOH/gram fluid	ļ				
Water acidity, mg KOH	1	1			_
Insolubles, %	Ì		İ		-
Thermal Stability Test		!			-
Fire Resistance		1	}		
Flash Point, F	375				ASTM D-97
Fire Point, *F	430				ASTM D=97
Autogeneous Ignition Temperature, F		ļ			ASTM D=2155
High-Pressure Spray Combustor		l	ļ		See MEL Report
Minimum spontaneous ignition	ŀ	1	İ		31/66 of Earch 1967
temperature, *F	İ	ľ	1		1907
Minimum reaction temperature,					
No indication of fire, °F		Ì			_
Maximum pressure change, psi	ŀ	1	1		_
Lowest temperature of maximum	ŀ	l	i		-
pressure change, °F	ł	1			
Temperature range explored, °F	1		1		-
Miscellaneous Properties	ľ				
Pour Point, F	-10				ASTM D-97
Foaming Tendency, 75° F		1			ASTM D-890
Foam after 5-minute aeration,	<10	[] .		-
ml	}	1	; }		
Time out, minutes	0				-
Foam after 10-minute settling,	0	Ì			-
ml					10mi n 001
Neutralization Number, mg KOH/gram	0.9	1			ASTM D-974
Water Content, # by weight Neutrality, qualitative	0.076				ASTM D-1744 Fed. Method :101
Contamination	Neutral				nethod (101
Number and size of particles and	<u>.</u> [SAE Method ARP-
fibers in 100-ml fluid	1				598
25-100 micrometers	582	,			-
100-500 micrometers	6				_
over 500 micrometers	6 fibers				_
particles over 250 microm-	0				_
eters except fibers (length	i				
ten times diameter)	1				
Gravimetric Value, mg/10C ml	8.9				SAE Method ARP-789
Specific gravity, 60/60 °F	0.889	1			ASAT D-1298
Color	3.5	1 _	١ ا		ASTM D-1500
Cost \$/gal	proprieta	from sup	plier		-
Availability	In. obriece	1			

Determinations made at atmospheric pressure, unless noted.

Fluid Code A

		Method
Material Compatibility wi	<u>th</u> :	See Chapter Test C-3
Buna S	Poor	
Matural Rubber	Poor	
Polyurethane	Good	

Based on atmospheric pressure data.

Fluid Code B

Suggested Uses and Possible Limitations

Fluid Code B, a petroleum oil product, was originally developed for missile use. Its viscosity at atmospheric pressure is too low for a general lubrication or hydraulic fluid over sustained time periods; however, it would be in the right viscosity range at great depths. It provides excellent corresion inhibition for ferrou metals but provides no protection for nonferrous metals. Its electrical resistivity is low and its dissipation factor is very high, making it questionable for known deep ocean electrical application. It is extremely flammable.

Fluid Code B⁽¹⁾ (Petroleum Base Fluid)

	T		j	 Method
Viscometric Properties Viscomity, centistokes, at:	55° F	100° F] 150° F	
0 prig				l
T.(K?) paig	1			See NSRDL
5,000 paiq 8,000 paiq	j			Annapolis Report
10,000 parq			[MATLAB 550
15,000 paig	j		ĺ	1]
20,000 paig	}			-
	ł		Í	
	ł			
	1)	
	ł			
	100			
Vixonsity, centistokes, at 100 °F, Viscosity, centistokes, at 210° Y,				ASTM D-445
O prig	1.50	i		ASIM DOTT
Viscosity Slope, ASTM	0.803			 -
Lubri ing Ability		1		
4.8al) Wear Test, 30 min, 50° C, 52100 steel, overage scar dia.,				Fed. Mathod 6'03
mm:		i 1		(modifiea)
1 kg				-
3 kg	ľ		İ	-
5 kg				-
				}
	!			
	}			ļ
		j	j	
Corresion Protection				
Stirred Rust Test, 10% Seawater,	Pass		ĺ	ASTM D-665
140° F, 2 days	1 4 13		i	1.511. 2-009
On-Off Rust Test, 50% seawates,	{			See Chapter ?
140° F, 30 days		j	j	Test C-5
Ambient Pressure, coupon	}			See Chapter ?
<pre>stirred, corrosion test, weight change, mg</pre>		}		Test C-1
"hoper	-39.2		1	-
.nless Steel, 316	+ 0.2			-
per-Nickel (70-30)	- 3.8		j	-
Aluminum, QQ-A-250-46 Phosphor-Bronze	+ 0 4			-
Steel, galvanize	-17.6 -16.6			-
Steel, 1009	- 3.2			_
Aluminum, 90-A-250-11	+ 0.3			-
Bronze	~20.9			-
Konal Silvet Base Brazing Alloy	- 0.2			-
20,000 P3IG Pressure-Cycled	-10.2			See Chapter ?
Corrosion Test (1% seawater),			1	Test C-2
weight change, mg			1	
Insulated Specimens:				
Copper		1		_
Stainless Stoel, 316 Copper-Nickel (70-30)			ļ	
Aluminum, QQ-A-250-4tb]	İ	1	-
Phosphor-Bronze			1	-
Steel, galvanized			İ	-
Steel, 1009		·	į	-
Alumin. ~, QQ-A-250-11		1	ļ	-
	1			
Bronte Monol			ì	-

	· · · · · · · · · · · · · · · · · · ·				
Collosion Protection (Cont)					Method
Electrically Coupled Specimens:		}	i	ł	
•	,	1	ı		1 -
Copper-Aluminum, QQ-A-250-11	1	1	1		-
Aluminum 00-A-250-45 -		1	ł		-
Copper-Nickel (70-50))	1			1
Monel-Bronze					-
Stainless Steel (516) -					-
Phosphor-Bronze	ł	1	1	1	ł
Silver Base Brazing Alloy -			1		•
Steel, 1004				İ	
Aluminum QQ-A-C+O-11 -]	J]	
Bronze			i		
Aluminum QQ-A-240-4b -		1		1	-
Steel, 1009					
20,000 FSIG Stirred Corrosion				i .	See Chapter :
Test, weight change, mg		ļ	i		Test C-4
Insulated Specimens:			ì	1	
Copper			l .		 -
Stainless Steel, 316]	}		} -
Copper-Nickel (70-30)		ł	1	į	-
Aluminum, QQ-A-250-4b				Í	-
Phosphor-Bronze		1	1	ļ	,
Steel, galvanized		ł		į	-
Steel, 1009		1	1		{ -
Aluminum, QQ-A-050-11		1			_
Bronze		1			_
Monel		1	1	1 .	1 _
Silver Base Brazing Alloy			1	İ	l <u> </u>
Electrically Coupled Specimens:		•			
Copper-Aluminum, QQ-A-250-11			į		1 _
Aluminum, QQ-A-250-4b -		Ì			l <u>-</u>
Copper-Nickel (70-30)					
Monel-Bronze			i		l _
Stainless Steel (316) -		1	İ	ł	1 [
Phosphor-Bronze					_
Silver Base Brazing Alloy -			ŀ		i
		ł	į.		-
Steel, 1009 Aluminum, QQ-A-250-11 -					
-					-
Bronze		İ			
Aluminum, QQ-A-250-4b -		Į	1		_
Steel, 1009		1			
Pump Test					Proposed military
Average Weight Loss, mg			1		specification for
Steel Gears']		ļ	sea-water emul:
Bronze Bushings				1	fying oils
Corrosion Coupons, weight loss,					
each, mg/cm ²			l	j	j
Copper					-
Aluminum			l	i	-
Steel, galvanized			i		-
Steel, 1009			}]	-
Silver Base Brazing Alloy		1			_
ielectric Properties	_	1	1	ļ	ASTM D-1169 (mod-
Resistivity, 76 °F. ohm-cm:	1.0×109	<u> </u>			ified) . See Chap-
As-Received		ł	i		ter 2. Test E-1
With Sea-Water Contamination:			1		Chapter 2
0.1% by volume					Test E-5
0.5% by volume	I	1	ĺ		
2.0% by volume			1		_
With Carbon Contamination:		[1		Chapter 2
0.1% wt/vol.			1		Test E-6
0.25% wt/vol.		i			reac E-0
0.25% wt/vol.			1		-
O'DA MEN ACT!		L	L	ı	-

				Madhad
	1			Method
Distectric Properties (Cont)			j	
After 50,000 Electric Arcs			ļ	See Chapter ?
(makes and breaks) at 90	ļ	1	1	Test P-7
volts, 10 amperes, resis-	ļ	1		
tive load	İ	1		
Not filtered		1	·	_
Filtered	1	1		·
	1	1		-
Solids generated, gram	1			-
Dissipation Factor, 76 P. \$		1		See Chapter ?
As-Received	>60	1	ł	Test E-2
With Sea-Water Contamination:	ł	! !		See Chapter 2
0.1% by volume	[- Test E-5
0.5% by volume		ļ		- Teac Lay
2.0% by volume		1 1]	-
		1		
With Carbon Contamination:		1	1	See Chapter 2
0.10% wt/vol.	İ	1		Test E-6
0.25% wt/vol.	}	1		-
0.50% wt/vol.				_
After 50,000 Electric Arcs				
(makes and breaks) at 90	l	1	· .	
volts, 10 amperes, resis-	1	ļ [
•	1	i l]	
tive load	1	ł I	i !	
Not filtered	ì	!		- i
Filtered	}	1		-
Solids generated, gram		į į		-
Dielectric Breakdown Voltage,	İ	Į		ASTM D-877 (mod-
0.05-inch gap, 76 °F, kv	25.4			ified). See Chap-
As received	2)• •	1		ter 2. Test E-3
1		j	l l	
With sea-water contamination:		l i		See Chapter 2
0.1% by volume			1	Test 2-5
0.5% by volume		1	}	-
2.0% by volume			l i	-
With carbon contamination:		1	1	See Chapte: /
0.10% wt/vol.	;	!	!	Test E-
0.25% wt/vol.				_
0.50% wt/vol.	1	! !		
	1	i I	1	-
After 50,000 electric arcs	!		i !	
(makes and breaks) at 90		1	1	1
volts, 10 amperes, resis-			i	
tive load	}			
Not filtered		1	j	: -
Filtered		ì		
	}	!	1	_
Solids generated, gram	1		i	See Chapter 2
Contact Life, silver-cadmium, 50			1	Test E-S
volts, 10 amperes, resistive	i i	1 İ	į	169C D-0
load, 6000 psi, 65°-85° F	Ì			
Number of tests	[1		•
Operations to failure (range)	ļ			
Emulsion Stability				
Faddle Test, after 1-hour set-			i	ASTM D-1401
	}	! !		
tling:	1 0 3	1		
Oil, mi	23			*
Emulsion, mi	57			-
Water, ml	0			• [
Electric Probe Test, time for	į]		See Chapter 2
water separation, min	ĺ	1		Test E-4
Material Compatibility Static 20KPSI) }	!		See Chapter ?
Butyl		1		Test C-3
· · · · · · · · · · · · · · · · · · ·				
Bun N				-
Viton B			l	-
Ethylene-Propylene				- i
Tetrafluoroethylene (Teilon)			1	-
Neoprene				-
Thickol				-
Silicone				
]			İ	
Fluorosilicone	1	L L	ı .	-

Volatility	1	1		-
Toxicity	Petroleum	İ		
Density, grams/cubic centimeter, at:	35° P	100° F	150° F	And the same and the same of t
0 paig				See NSRDL
3,003 paig		i	1 1	Annapolis Report
5,000 paig	1	1	1	MATLAN 350
8,000 psig		1	1	
10,000 paig	1	[
15,000 pmig	1			1
20,000 pmig		}]	
Saothermal Compressibility, volume	35° F	100° F	150° F	
decrease, %, at:				See NSkbL
0 paig		J]	Annapolis Report
3,000 paig		1		MATLAB 350
5,000 paig	i	Į		
8,000 paig	·	1		}
10,000 paig	j	ļ	j j	1
15,000 paig	}	<u> </u>]	i
20,000 paig	<u> </u>			
Chemical Stability	1		1	
Oxidation Stability Test, 203° F,	}	j	1 1	ASTM D=943
hours to failure	Į.		1	
Oxidation Stability Test, 250° F	1	į	1	Fed. Method 5308
Hydrolytic Stability Test]	ļ	1	Military specifi
Specimen change, mg	1	0.12	L I	cation MIL-H-
Specimen appearance	Į	Satisfa ct	1 - 1	19457B
Fluid acid number increase,	1	0.21	}	_
mg KOH/gram fluid	1		1	
Water acidity, mg MOH	ļ	10	1	-
Insolubles, *	1	nil)	-
Thermal Stability Test	ŀ		1	-
Fire Resistance	1		1	3 - 5 M
Flash Point, F	205		1	ASTM D-92
Fire Point, °F	215		1	ASTM D-98
Autogeneous Ignition Temperature,	1		į	ASTM D-2 15:
High-Pressure Spray Combustor	1		1	See MLL Forward 51/66 of Naire
Minimum spontaneous ignition temperature, °F	1			1967
Minimum reaction temperature,]	1967
°F	1		1	\ -
No indication of fire, °F	}]	
Maximum pressure change, psi	1			-
Lowest temperature of maximum	1		1 1	ļ -
pressure change, °F				-
Temperature range explored, °F	1		į į	
discellaneous Properties	1		1	-
Pour Point, F	-		1	AS 1 D=97
Foaming Tendency, 75° F				ASTM D-01/2
Foam after 5-minute aeration,	1		()	ASTA DE SA
ml	1		1	
Time out, minutes			1	_
Foam after 10-minute settling,				
ml				1
Neutralization Number, mg KOH/gram	0.09		1	ASTM D=774
Water Content, % by weight	,			ASTM D-1744
Neutrality, qualitative			1	Fed. Method 1 1
Contamination	1		1	
Number and size of particles and	al			SAE Method AFF=
fibers in 100-ml fluid				98
25-100 micrometers	1		1	
100-500 micrometers	[_
over 500 micrometers			1	-
particles over 250 microm-				_
eters except fibers (length	Į l		1	Ì
ten times diameter)				
Gravimetric Value, mg/100 ml	(,		SAE Method Arr. /
Specific gravity at 70/70 °F	0.852		1	1
Color	0.096			ASTM D-1.98
Cost \$/gal	Available	from supi	blier	-
Vailability	proprieta			-
Determinations made at atmospheric pr			·	

Fluid Code C

Suggested Uses and Possible Limitations

As a petroleum oil product, Fluid Code C has viscosity properties similar to those of MIL-H-46004 and has been used as an immersion medium for electric motors at pressures corresponding to a depth capability of 20,000 feet. Its viscosity is too low at atmospheric pressure to consider it as a general lubricant over sustained periods of time. It shows good corrosion inhibition for both ferrous and nonferrous metals. It has a low electrical resistivity and a high dissipation factor, making it questionable for any known deep ocean electrical application. It is extremely flammable.

Fluid Code C(1)

(Petroleum Base Fluid)					
					Method
Viscometric Properties	50° F(2)				
Viscosity, centistokes, at:	50 F	100° r	150° F		
Cpaig	12	ļ			
3,000 paig	17	1			See Nakul.
5,000 paig	22	l	İ		Annapolis hepor!
8,000 paig	32	1	l		NATLAB 150
10,000 paig	42	1	ļ		-
15,000 paig	82	!	[
20,000 paig	180		ĺ		
			1		
			ŀ		
			•		1
			1		1
			1		
			1		
Viscosity, centistokes, at 100 °F.	3.73		<u> </u>		
Viscosity, centistokes, at 210° F,	1.41		1		ASTN D-445
0 paig	_		ŀ		
Viscosity Slope, ASTM	0.825				
Lubricating Ability					0 4 11.00 - 40.00
4-Ball Wear Test, 30 min, 50° C,			l		Fed. Method (50)
52100 steel, average scar dia.,					(modified)
mdn.:			ì		
1 kg	0.18			l	_
3 kg			l film lo		_
5 kg	0.30 (sc	uffing, o	l film to	Bt)	_
		i			
1					
	ł				
Corrosion Protection	ŀ		Ì		
Stirred Rust Test, 10% Seawater,	Pass		l		ASTN 1 SC
140° F. 2 days	rass				
On-Off Rust Test, 50% seawater,			1		See Chapter :
140° P. 30 days			1		Test C-'
Ambient Pressure, coupon			ļ		See Chapter (
stirged, corrosion test, weight			1		Test C-1
change, mg		•	Ì		
Copper	-17.8	İ	<u> </u>		-
Stainless Steel, 316	+ 0.3]			-
Copper-Nickel (70-50)	- 0.4		1		-
Aluminum, QQ-A-250-4b	+0.6				<u> </u>
Phosphor-Bronze	- 5.5	1	1		_
Steel, galvanized	- 0.2				<u> </u>
Steel, 1009	+ 0.2				<u> </u>
Aluminum, QQ-A-250-11	+ 0.4)		
Bronze Monel	- 5.6		1		
Silver Base Brazing Alloy	+ 0.2	i	1		
20,000 PSIG Pressure-Cycled	- 5.2	1	1		Sec Chapter :
Corrosion Test (le seawater),	1	1			Tcs*: C-1
weight change, mg			!		
Insulated Specimen:		l	1		
Copper	Í				· -
Stainless Steel, 316			1		-
Copper-Nickel (70-30)					-
Aluminum, QQ-A-250-4b			1		-
Phosphor-Bronze	1]	1		-
Steel, galvanized	1		1		-
Steel, 1009			!		-
Aluminum, QQ-A-250-11	Į	i	1		•
Bronze	1		1		-
Monel	1	[-
Silver Base Brazing Alloy	i	I	1	I	ı -

The state of the s	,	Method
Construct Mention to (c) and		Mart nod
Corrosion Protection (Cont)		1
Lifetimally Coupled Specimens:	} }	1 -
Copper-Aluminum, Wy-A-150-11]	•
Aluminum QQ-A-250-4b -		-
Copper-Nickel (70-50)	, j j	į į
Monel-Bronze	i i l	-
Stainless Steel (516) -		-
Phosphor -Bronze	1 1 1	{
Silver Base Brazing Alloy -	1 1 1	i <u>-</u>
Steel, 1004	i	
Aluminum QQ-A-250-11 -		_
Bronze	1 1 1	1
Aluminum QQ-A-250-4b -		
		*
Steel, 1009		l
20,000 PSIG Stirred Corrosion	(10% seawater)	See Chapter (
Test, weight change, my		Test C-4
Insulated Specimens:	i i	
Copper	-1.4	-
Stainless Steel, 316	-1.3	-
Copper-Nickel (70-30)	-0.3	ļ <u>-</u>
Aluminum, QQ-A-250-4b	+0.1	-
Phosphor-Bronze	+0.1	1 -
Steel, galvanized	-0.2	j <u>.</u>
Steel, 1009		1 -
Aluminum, QQ-A-250-11	-0.3	
Bronze	+0.2	
	-1.3	-
Monel	-2.1	-
Silver Base Brazing Alloy	-4.7	-
Electrically Coupled Specimens:		
Copper-Aluminum, QQ-A-250-11	-2.2 +(-
Aluminum, $QQ-A-250-4b$]]]	ļ -
Copper-Nickel (70-50)	1-0.3 -0.5	
Monel-Bronze	+0.2 +0.6	-
Stainless Steel (516) -		-
Phosphor-Bronze	+0.8 +0.7	
Silver Base Brazing Allo: -	1.0.0	l -
Steel, 1009	+0.2 +0.1	ĺ
Aluminum, QQ-A-250-11 -	+1.2 +0.5	<u>-</u>
Bronze	71.2 70.7	
Aluminum, QQ-A-250-4b -		<u> </u>
	+0.1 -0.1	
Steel, 1009		Description and milk active
Pump Test		Proposed military
Average Weight Loss, mg		specification for
Steel Gears		sea-water emuls
Bronze Bushings		fying oils
Corrosion Coupons, weight loss,	l 1	ł
each, mg/cm²		
Copper		-
Aluminum		<u>-</u>
Steel, galvanized		j -
Steel, 1009		-
Silver Base Brazing Alloy		1 -
Dielectric Properties		ASTM D-1169 (mod-
Resistivity, 77 °F, ohm-cm:	4.0×108	ified). See Chap-
As-Received	''•	ter ? . Test E-1
With Sea-Water Contamination:		Chapter 2
0.1% by volume		Test E-G
* * *		1686 12-
0.5% by volume		-
2.0% by volume		
With Carbon Contamination:		Chapter 2
0.1% wt/vol.		Test E-6
0.25% wt/vol.		 -
0.5% wt/vol.	1 1 1	-

Dielectric Properties (Cont)		Method
After 50,000 Electric Arcs		See Chapter ;
(makes and breaks) at 90		Test E-7
volts, 10 amperes, resis-	1 1 1	Test E-1
tive load		
Not filtered	1 1	
Filiered]] [
Solids generated, gram		
Dissipation Factor, 77 .		See Chapter ?
As-Received	>60	Test E-2
With Sea-Water Contamination:		See Chapter ?
C.1% by volume		- Test E-'
0.5% by volume	1 1 1	- 1680 2-7
2.0 by volume		-
With Carbon Contamination:	1 1	See Chapter ?
0.10% wt/vol.		Test E-6
0.25% wt/vol.	1 1	1000 E-C
0.50% wt/vol.		-
After 50,000 Electric Arcs		-
(makes and breaks) at 90		
volts, 10 amperes, resis-		
tive load	1 ! !	
Not filtered		
Filtered	1 1	-
Solids generated, gram		-
Dielectric Breakdown Voltage,		
0.05-inch gap, 77 °F, kv		ASTM D-877 (mod-
As received	28.4	ified). See Chap-
With sea-water contamination:	20.4	ter 2. Test E-3
0.1% by volume		See Chapter 2
0.5% by volume	1 1	Test E-5
2.0% by volume		-
With carbon contamination:		3
0.10% wt/vol.		See Chapter ?
		- Test E-6
0.25% wt/vol.	1	-
0.50% wt/vol.]	-
After 50,000 electric arcs		
(makes and breaks) at 90		
volts, 10 amperes, resis-		
tive load		
Not filtered	! !	-
Filtered		-
Solids generated, gram	.]]	-
Contact Life, silver-cadmium, 50		See Chapter (
volts, 10 amperes, resistive	, ,	Test E-3
load, 6000 psi, 65°-85° F		
Number of tests		-
Operations to failure (range)		
Emulsion Stability		
Paddle Test, after 1-hour set-		ASTM D=1401
tling:		
Oil, ml	25	-
Emulsion, ml	55	-
Water, ml	0 }	_
Electric Probe Test, time for		See Chapter ?
water separation, min		Test E-4
Material Compatibility Static 2CKPSI		See Chapter (
Buty1		Test C-5
Buna N	}	_
Viton B	[-
Fthylene-Propylene	Į	-
retrafluoroethylene (Teflon)	[-
Neoprene		_
Thiokol	(_
!	1	
Silicone	1 1	1 -

Wolatility	ł	1	1		Method
Toxicity		1	1		1 -
Density, grame/cubic continuter, at:	Petroleu	73° F	17.00		
O paig	12		150° F	4	des Ments
	0.860	0.652	ļ	I	See NERDL
3,000 peig	0.871	0.864	ļ		Annapolis Report
5,000 peig	0.879	0.872			NATLAB 550
8,000 paig	0.888	0.882		l]
10,000 paig	0.896	0.889	:		
15,000 peig	0.909	0.903			•
30,000 berd	0.923	0.917			
Compressibility, wolume decrease,	52	73	100 P	l	
S, atı				ļ	See MSRDL
O paig	l .		l	İ	Annapolis Report
3,000 paig	1.4	1.5	1.7	}	MATIAB 350
5,000 patg	2,2	2.3	2.6	1	ł
8,000 paig	3.3	3.5	3.8		Į.
10,000 paig	3.9	4.2	4.6	i	
15,000 paig	5.5	5.7	6.3	1	
20,000 paig	6.8	7.1	7.8		
Chemical Stability				Ī	1
Oxidation Stability Test, 203° F,			Ì	<u> </u>	ASTM D-945
hours to failure		ļ	1		1
Oxidation Stability Test, 250° F			l	Į.	Ped. Method 5308
Mydrolytic Stability Test	}		1]	Military specifi
Specimon change, mg			l		cation MIL-H-
Specimen appearance			l	ĺ	19457B
Fluid acid number increase,	1		j	j	1 -
mg NOH/gram fluid	į į				
Water acidity, mg MDH			1	ļ	-
Insolubles, %			i		-
Thermal Stability Test	[ĺ	ĺ	[-
Fire Resistance			i		Ì
Flash Point, "F	200		1		ASTM D-92
Fire Point, °F	550		1		ASOM D-92
Autogeneous Ignition Temperature, F]		ASTM D-2155
High-Pressure Spray Combustor			ì		See MEL Report
Minimum spontaneous ignition			ļ		51/66 of March
temperature, "F			[1967
Minimum reaction temperature,					
• 7					
so indication of fire, "F			ł		1 -
Martimus pressure change, psi	[[ĺ	1_
Lowest temperature of maximum	1		1		_
pressure change, 'F					
Temperature range explored, "F	[[1 -
Miscellaneous Properties	1		[
Pour Point, F	<-90				ASTM D-97
Foaming Tendency, 75° F	\ /-		1		ASTM D-802
Form after 5-minute meration.					-
al	1 1				
Time out, minutes	1	'			_
Foam after 10-minute settling,					_
ml	}		Ì		
Meutralization Number, mg NOH/gram	0.09	'			ASTM D-974
Water Content, % by weight	"."				ASTM D-1744
Meutrality, qualitative					Fed. Method 101
Contamination					_ red. nection . for
Number and size of particles and	į į				SAE Method ARP-
fibers in 100-ml fluid	ו		ĺ		508 APTHOO NAP-
25-100 micrometers	Į l				240
100-500 micrometers	(
over 500 micrometers					_
=					-
particle: over 250 microm-]				-
eters except fibers (length	1 !				
ten times dimmater)					
Gravimetric Value, mg/100 ml					SAE Method ARP-75
appecific gravity at 70/60 °F	0.858				ASTM D-1298
Color	1 1	_	l		ASTH 0-1500
Cost \$/gml	Available				

Determinations made at atmospheric pressure, unless noted.

Fluid Code D

Suggested Uses and Possible Limitations

Fluid Code D has been suggested for use in a friction drive system. Its relatively high viscosity and lack of corrosion inhibition make it questionable for use as a general petroleum lubricant or hydraulic fluid. Its dielectric properties have not been determined. It is flammable.

Fluid Code D(1)
(Petroleum Base Fluid)

	(Petroleum	Base Flui	d)		
	T	Τ	1	<u> </u>	Method
Viscometric Properties	1	1			
Viscosity, centistokes, at:	55° ₽	100° r	150° F		
O paig		19.7			
3,000 psig		-	i		See New Departure
5,000 paig		53.2			Letter to NSRDC.
8,000 paig	İ				26 Feb 1968
10,000 paig		į.			-
15,000 paig	ĺ	i			-
20,000 psig	1				-
İ	1				
	1				
	1				
	1				
Viscosity, centistokes, At 100 °F	15.7]			
Viscosity, centistokes, at 210° F	3.86				ASTM D-445
0 psig	1				
Viscosity Slope, ASTM	0.776				-
Lubricating Ability					
4-Ball Wear Test, 30 min, 50° C,	1				Fed. Method 650;
52100 steel, average scar dia.,					(modified)
mn:	1				
1 kg					-
3 kg				•	-
5 kg					-
					<u>.</u>
	1	i I			
	i				ł
Corrosion Protection	1				
Stirred Rust Test, 10% seawater,					ASTM D-665
140° F, 2 days	Fail				
On-Off Rust Test, 50% seawater,	Fail				See Chapter 2
140° F, 30 days	i	ì			Test C-5
Ambient Pressure, coupon		i i			See Chapter 2
stirred, corrosion test, weight					Test C-1
change, mg	i				
Copper	- 50.1				-
Stainless Steel, 316	+ 0.6				-
Copper-Nickel (70.30)	- 0.7				-
Aluminum, QQ-A-250-45	-133.5				-
Phosphor-Bronze	- 70.7				-
Steel, galvanized	-290.5				-
Steel, 1909	-828.6				-
Aluminum, QQ-A-250-11	- 25.8				-
Bronze	- 33.1				-
Monel	+ 0.5				-
Silver Base Brazing Alloy	- 2.5				
20,000 PSIG Pressure-Cycled	Í .				Sec Chapter 2
Corrosion Test (1% seawater),	ì				Test C-2
weight change, mg					1
Insulated Specimens:	1		ŀ		}
Copper					1 -
Stainless Steel, 316					-
Copper-Nickel (70-30)					1 -
Aluminum, QQ-A-250-4b		ļ			1 -
Phosphor-Bronze]			-
Steel, galvanized	1		i		-
Steel, 1009					
1 23			į		1 -
Aluminum, QQ-A-250-11			į] -
Bronze			i ; ;		-
			; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ;		-

		r			Method
Corrosion Protection (Cont)					
Electrically Coupled Specimens:					-
Copper-Aluminum, QQ-A-250-11					-
Aluminum QQ-A-250-4b -					j -
Copper-Nickel (70-50)					
Hone 1 - Bronze] -
Stainless Steel (316) -					-
Phosphor-Bronze					
Silver Base Brazing Alloy -					1 -
Steel, 1004					
Aluminum Q0-A-250-11 -					-
Bronze					1
Aluminum QQ-A-250-4b -					1 -
Steel, 1009	l				See Chapter 2
20,000 PSIG Stirred Corrosion					Test C-4
Test, weight change, mg					14.6
Insulated Specimens:					
Copper					-
Stainless Steel, 316					1 -
Copper-Nickel (70-30)					
Aluminum, QQ-A-250-4 b					1 -
Phosphor-Bronze		İ			1 _
Steel, galvanized					1 -
Steel, 1009					
Aluminum, QQ-A-250-11		1			<u> </u>
Bronze					1 -
Monel					1]
Silver Base Brazing Alloy					1 ~
Electrically Coupled Specimens:					
Copper-Aluminum, QQ-A-250-11		ĺ			
Aluminum, QQ-A-250-4b -					_
Copper-Nickel (70-30)					1_
Monel-Bronze Stainless Steel (316) -					1 _
					<u> </u>
Phosphor-Bronze					1 _
Silver Base Brazing Alloy -	-				
Steel, 1009 Aluminum, QQ-A-250-11 -					_
Bronze Aluminum, QQ-A-250-4b -		1			i _
Steel, 1009					
					Proposed military
Pump Test					specification for
Average Weight Loss, mg Steel Gears		1			sea-water emulsi-
Bronze Bushings		!			fying oils
Corrosion Coupons, weight loss,					1 -7, 0
each, mg/cm ²					
· -					l _
Copper					1 _
Aluminum Steel, galvanized					i _
Steel, 1009					1 _
		1			1 _
Silver Base Brazing Alloy	j				ASTM D-1169 (mod-
Dielectric Properties Resistivity, °F, Ohm-cm:		1			ified). See Chap-
Resistivity, F, Orm-cm: As-Received	l				ter 2 Test E-1
With Sea-Water Contamination:	1				Chapter 2
0.1% by volume					Test E-5
0.1% by volume 0.5% by volume	l	·			
	l				1 _
2.0% by volume With Carbon Contamination:	i	ĺ			Chapter 2
0.1% wt/vol.	l	<u> </u>			Test E-6
0.1% wt/vol.	{	ĺ			
0.5% wt/vol.	{	1			
U. JA WL/ VUL.			L	L	1 "

		1		[· · · · · · · · · · · · · · · · · · ·	Method
Atter 50,000 Electric Arcs			,		See Chapter F
l l		į			Test E-7
(makes and breaks) at 90 volts, 10 amperes, resis-		1			1030 11
tive load		į			
Not filtered		ļ			_
Filtered		İ			_
Solids generated, gram					-
Dissipation Factor, F, 4		ì			See Chapter (
As=Received					Test L-P
With Sea-Water Contamination:					See Chapter ?
0.1% by volume					_ Test E-1/
0.5% by volume					-
2.0% by volume					-
With Carbon Contamination:					See Chapter ?
0.10% wt/vol.					Test E- 6
0.25% wt/vol.		ļ			-
0.50% wt/vol.					-
After 50,000 Electric Arcs					
(makes and breaks) at 90					
volts, 10 amperes, resis-		1			
tive load]			ļ
Not filtered		ĺ			-
Filtered					-
Solids generated, gram Dielectric Breakdown Voltage,					ASTM D-877 (mod-
0.05-inch gap, °F, kv					ified). See Chap-
As received					ter?. Test E-3
With sea-water contamination:					See Chapter 2
0.1% by volume					Test E-5
0.5% by volume		1			-
2.0% by volume		l i			_
With carbon contamination:		1			See Chapter 2
0.10% wt/vol.		1			- Test E-6
0.25% wt/vol.					-
0.50% wt/vol.					-
After 50,000 electric arcs					
(makes and breaks) at 90					
volts, 10 amperes, resis-					
tive load					
Not filtered					-
Filtered					-
Solids generated, gram					- Con Chamter 3
Contact Life, silver-cadmium, 50		1			See Chapter 2 Test E-8
volts, 10 amperes, resistive load, 6000 psi, 65°-85° F		1			Test E-5
Number of tests		1			_
Operations to failure (range)					_
Emulsion Stability		i			
Paddle Test, after 1-hour set-					ASTM D-1401
tling:					
Oil, ml	40	1			-
Emulsion, ml	0				
Water, ml	40]			_
Electric Probe Test, time for]			See Chapter 2
water separation, min					Test E-4
Material Compatibility Static 20KPSI] [See Chapter 2
Butyl]			Test C-3
Buna N]			-
Viton B		į l			-
Ethylene-Propylene		}			-
Tetrafluoroethylene (Teflon)					•
Neoprene		[-
Thickol					-
Silicone				ı	-
Fluorosilicone			ı i		-

	т			and the same of th	Method
Volatility					
	Petroleus	100° F	150 1		
Density, grans/cubic centimeter, atr					See NSRDL
1,000 ps 14	1	İ			Annapolis Report
5,000 parq					MATIAN 550
8,000 parq	l	ŀ	1		1
10,000 para					
15,000 ps 14			1		
20,000 ps td	35 F	100° F	-150°F		
I Southerman Company					See NSRDL
decrease, a. att	j	1	!		Annapolis Report
C paid	ļ				NATLAB 550
5,000 para	1	İ	_ \		
8,000 ps14	į		1		1
16.660 bard	1		-		
15,000 psig			1		
20,000 pstq					
Chemical Stability		i			ASTN D=943
Oxidation Stability Test, 205 F.		1			
hours to failure					red. Method 5308
Oxidation Stability Test, 250° F		ļ			Military specifi-
Hydrolytic Stability Test Specimen change, my					cation MIL-11-
Specimen change, and Specimen appearance	1				19457в
Fluid acid number increase,					-
my KOH/gram fluid					
Water acidity, mg NOH					\ -
Insolubles. X					1 -
Thermal Stability Test					-
Fire Resistance					ASTM D-02
Flash Point, "F	270	Ì '			ASTM D-32
Fire Point. °F	295]]	į	ASTM D-2155
Autogeneous Ignition Temperature, F			1		See MIL Report
High Pressure Spray Combustor		İ	ļ		31/66 of March
Minimum spontaneous ignition		1	1	!	1967
temperature, °F Minimum reaction temperature,		ļ			-
%F	ĺ		1		· ·
No indication of fire, "F	ŀ		1		-
Maximum pressure change, psi			1		-
Lowest temperature of maximum		1		1	\ -
nressure change, °F]	1		1	ł
Temperature range explored, "F	Į.	1		}	-
Miscellaneous Properties]	1		ASTM D-97
Pour Point, F	-60	į	1		ASTM D-892
Foaming Tendency, 75° F	! -	1			-
Foam after 5-minute aeration,	İ				İ
ml	1		1		-
Time out, minutes	<1		1	1	-
Foam after 10-minute settling,	"	1	1	1	
ml Neutralization Number, mg KOH/gram	0.01	1	1	1	ASTN D-974
Water Content, % by weight	0.010	. [1		ASTM D-1744
Neutrality, qualitative	neutral	1	1		Fed. Method 5101
Contamination	1	j	1	ì	SAE Nethod ARP-
Number and size of particles and	리	1	1	1	598
fibers in 100-ml fluid		1		1	1,50
25_100 micrometers	1	ļ	1		1 -
100-500 micrometers	i	i	1	i	1 -
over 500 micrometers	1	1	1	1	-
particles over 250 microm-	1				
eters except fibers (length		ŀ	1		
ten times diameter) Gravimetric Value, mg/100 ml		1	1	1	SAE Method ARP-7
Specific gravity at 60/60 °F	0.837	ŀ	1		ASTM D-1298
		1	1	1	ASTM D-1500
Color	Availab	e from su	pplier	1	-
Cost 3/gal	proprie				

Availability

Determinations made at atmospheric pressure, unless noted.

Fluid Code E

Suggested Uses and Possible Limitations

Fluid Code E is used in submersible motors. There is considerable field experience to show that this fluid may be used as a motor immersion fluid. Its viscosity is low, it provides no corrosion protection, and it is extremely flammable. Initial dielectric properties are good, but additional information relating to electrical applications is lacking.

. .

Fluid Code E(1)

(Petroleum Hase Fluid

	(Petroleu	m Hase Flu	id)	
				 Method
Viscometric Properties Viscosity, centistokes, at:	35° F	1000	1	
O paig	25 F	100° F	1:,0° F	
3,000 paig	ł	ł		a. w. un.
5,000 paig		ļ		See NSRDL
8,000 paig				Annapolis Report
10,000 psig				MATLAB 350
15,000 paig				
20,000 paig]	1 [
	1	ľ		_
	i .			
	j	1		J
	1			
	1			
l .	1		1	1
Viscosity, centistokes, at 100 °F.	4.26	,		
Viscosity, centistokes, at 100 F.		<u> </u>		
O psig	1.50	!		ASTM D-445
Viscosity Slope, ASTM	0.839	1		
Lubricating Ability	1 0.009	 		
4-Ball Wear Test, 30 min, 50° C.	[[Fed. Method 6503
52100 steel, average scar dia.,	ļ	[1	(modified)
mm:	j	j j]	(
1 kg			}	-
3 kg		l		_
5 k g			i	i -
	ļ			
	}	}	1	}
	1			1
			ĺ	
Corrosion Protection		i	ł	1
Stirred Rust Test, 10% seawater,			l	ASTM D-665
140° F, 2 days	Fail			ASIM D-005
On-Off Rust Test, 50% seawater,			1	See Chapter ?
140° F, 30 days	Fail			Test C-5
Ambient Pressure, coupon	[]	[See Chapter 2
stirred, corrosion test, weight		1	-	Test C-1
change, mg	}	}]	
Copper	- 74.2		1	-
Stainless Steel, 316	+ 1.2	!	}	-
Copper-Nickel (70-30)	+ 0.7		Ì	-
Aluminum, QQ-A-250-4b Phosphor-Bronze	-456.5	İ	1	-
Steel, galvanized	- 25.9 -1227.4		ŀ	† *
Steel, 1009	-1598.2	ł	1	-
Aluminum, QQ-A-250-11	+ 159.7	ŀ		_
Bronze	- 46.7	İ	ļ	-
Mone:	+ 0.1	1	1	_
Silver Base Brazing Alloy	- 17.3	Ì		
20,000 PSIG Pressure-Cycled] [}	See Chapter?
Corrosion Test (1% seawater),		ſ	1	Test C-2
weight change, mg				
Insulated Specimens:	J		}	
Copper		ì		-
Stainless Steel, 316]		-
Copper-Nickel (70-30)		l	l	-
Aluminum, QQ-A-250-4b Phosphor-Bronze		1		-
Phosphor-Bronze Steel, galvanized		j	į	-
Steel, 1009	ľ	1	}	_
Aluminum, QQ-A-250-11	1	- 1	1	_
Bronze			ŀ	_
Monel	[ĺ		_
Silver Base Brazing Alloy	1	1		_
	·			 i

Correcton Protection (Sent)					Method
Utset creally Coupled Specimens	.1	1		1	1
Copper - Aluminum, QQ-A-150-11					-
Aluminum QQ-A-(10-hb =	1	1			-
Copper =Nickel (70.40)		1] -
Mon Bronze	ŀ			ľ	
St. aless Steel (416) =	1	1	1	1	} -
P. osphor-Bronzi	ļ		1		-
Silver Base Brazing Alloy -					
Steel, 1004	1	1	i	ì	_
Aluminum go-A-Cho-11 -	}			ĺ	_
Bronze					
Aluminum QQ-A=150-4b =		ì	1		_
Steel, 100)	1])	J
20,000 PSIG Sture Cottonion	1		1		Sec Chapter !
Test, weight Change, my			}	1	Test C-4
Insulated Specime of	1			j	
Copper	1		1		-
Stainless Steel, 516					-
Copper=Nickel (70-30)	1		1	İ	-
Aluminum, QQ-A-(%0-4b	Į.		1	1	-
Phosphor -Bronze	1	İ			-
Steel, galvanized		ł			-
Steel, 1000	1	1	}	1	-
Aluminum, QQ-A-(150-11 Bronze					-
Mone1	ļ.				-
Silver Base Brazing Alloy		İ			-
Electrically Coupled Specimens:	.1	1	1		1 -
Copper-Aluminum, QQ-A-250-11		1	1		1
Aluminum, QQ-A-250-4b -		1			ļ -
Copper-Nickel (70-30)	ŀ		1		-
Monel-Bronze					l _
Stainless Steel (516) -		ŀ			!
Phosphor-Bronze	i	ļ	}		1
Silver Base Brazing Alloy -		l			-
Steel, 1009	[1	[
Aluminum, QQ-A-250-11 -	!				-
Bronze	i				
Aluminum, QQ-A-250-4 b -				İ	-
Steel, 1009				1	}
Pump Test					Proposed military
Average Weight Loss, mg		1			specification for
Steel Gears	1	ļ	ļ		sea-water emulsi-
Bronze Bushings Corrosion Coupons, weight loss,	i				fying oils
each, mg/cm ²		i			
Copper	1				
Aluminum	1	1	ł	1	_
Steel, galvanized		1			
Steel, 1009					_
Silver Base Brazing Alloy	1		1		_ [
Dielectric Properties	1	ĺ	1	ľ	ASTM D-1169 (mod-
Resistivity, 73 °F, ohm-cm:	2.6x10 ¹³			i	ified). See Chap-
As-Received		1			ter 2. Test E-1
With Sea-Water Contamination:	J]	J	Chapter 2
0.1% by volume					Test E-5
0.5% by volume			1		-
2.0% by volume	j		ļ	J	•
With Carbon Contamination:					Chapter 2
0.1% wt/vol.					Test E-6
0.25% wt/vol.					-
0 5% wt/vol.	1	i	ĺ	1	ı . .

1.5.5.5	1 .	1	f · · · · ·	1
Duck Stric Properties (Cont)			ľ	- M() !
Atter 50,000 Fteetine At a				See Chapter 1
(nake and Freaks) at no				Test 1 /
colto, to amperou, resis-	1			
tave ford				
Not filtered	1			-
Filtered				_
Solith generated, gram				-
Dissipation Factor, 75 °F, 6	0.8			Sea Chapter ' Test F 1
With Sex-Water Contamination:		1		1
C.17 by volume	ľ	1		See Chapter 1
O.1. by volume		1		1080 10
2.0° by volume				~
With Carbon Contamination:	1			See Chapter 1
0.10" wt/vol.	ì		ļ	Test E-C
O.PR" wt/vol.				_
0.40% wt/vol.		1 1		_
After '0,000 Electric Arcs				
(makes and breaks) at 90				
volts, 10 amperes, resis-		1		
tive load				
Not filtered Filtered	1			-
Solids generated, gram			İ	-
Dielectric Breakdown Voltage,				ASTM D-877 (mod-
0.05-inch gap, 73 °F, kv				ified). See Chap-
As received	27.2			ter 2. Test E-3
With sea-water contamination:	' ' ' -	!	ļ	See Chapter 2
0.1% by volume				- Test E-5
0.5% by volume				-
2.0% by volume				-
With carbon contamination:				See Chapter ?
0.10% wt/vol.				Test F-6
0.25% wt/vol.				-
0.50% wt/vol.		1		-
After 50,000 electric arcs (makes and breaks) at 90		1		
volts, 10 amperes, resis-				
tive load				
Not filtered				1 _
Filtered	l	1		
Solids generated, gram	İ			_
Contact Life, silver-cadmium, 50]			See Chapter 2
volts, 10 amperes, resistive	1			Test E-3
load, 6000 psi, 65°-85° F	1	1		1
Number of tests				-
Operations to failure (range)				
Emulsion Stability				10my 5 3403
Paddle Test, after 1-hour set- tling:				ASTM D-1401
Oil, ml	40			
Emulsion, ml	40			
Water, ml	40			
Electric Probe Test, time for				See Chapter ?
water separation, min				Test E-4
Material Compatibility Static 20KPSI				See Chapter ?
Butyl				Test C-3
Buna N				-
Viton B				-
Ethylene-Propylene				-
Tetrafluoroethylene (Teflon)				-
Neoprene Thiokol				-
Silicone				
Fluorosilicone				
				

		7		·	Method
Volatility	}	ł			Me CHOC
Toxicity		1		[
Density, grams/cubic centimeter, at:	75 F	100° F	190°F		
Opsig	-				See NSRDL
1,000 paig		i			Annapolis Report
5,000 paig	1	1			MATLAB 550
8.000 psiq		i			
10,000 psig		Į.			
15,000 paig	1	[
20,000 paig	}	}			
Isothermal Compressibility, volume	SEA E	100° F	13.02.E		the second of th
decrease, %, at:					Sec MSRDL
0 paig					Annapolis Pepuit
3,000 paig		'			NATIAB 350
5,000 paig	1	. 1			
8,000 psig		,			,
10,000 psig	1) ·			
15,000 psig	\	l		' 1	
20,000 prig	.				
Chemical Scability	}				
Oxidation Stability Test, 203° F.]				ASTH D-943
hours to failure	}		,		
Oxidation Stability Test, 250° F	j] .			Fed. Method 5308
Hydrolytic Stability Test)	,	1		Military specific
Specimen change, mg	ì			ļ.	cation MIL-H-
Specimen appearance		}			19457в
Fluid acid number increase,	}	}			-
mg KOH/gram fluid					
Water acidity, mg KOH	}	l			-
Insolubles, \$					-
Thermal Stability Test	}	}			-
Fire Resistance] _	} !			
Flash Point, F	185)			ASTM D-92
Fire Point, F	190	})	ASTM D-92
Autogeneous Ignition Temperature, T)	j			ASTN D-2155
High-Pressure Spray Combustos	1	į			See MEL Report
Minimum spontaneous ignition	1				31/66 of March
temperature, °F		}			1967
Minimum reaction temperature,]	Ì			-
°F	1 .]			
No indication of fire, "F]	1			-
Maximum pre sure change, psi	}	ļ			-
Lowest temperature of maximum	1	}			-
pressure change, "F Temperature range explored, "F	ł	}			
,	l .	ł			_
Miscellaneous Properties Pour Point, F	{ .	Ì			ASTM D-97
Framing Tendency, 75° F	l I	l		•	ASTM D-892
Foam after 5-minute aeration,	}	Ì			L L L L L L L L L L L L L L L L L L L
ml	!	{			
Time out, minutes	1	.			_
Foam after 10-minute settling,	{				1 [
mi	Į .				
Neutralization Number, mg KOH/gram	{				ASTM D-974
Water Content, \$ by weight	{	{		İ	ASTM D-1744
Neutrality, qualitative	{	Į	l		Fed. Method 5101
Contamination	1	{]		
Number and size of particles and	d I	[SAE Method ARP-
fibers in 100 ml fluid	1	(598
25-100 micrometers	1	(1		
100-500 micrometers			ĺ		_
over 500 micrometers	1	(į	•	_
particles over 250 microm-	1	ſ			-
eters except fibers (length	1	}		i I	
ten times diameter)	1	}	'		
Gravimetric Value, mg/100 ml	}				SAE Method ARP-785
Specific gravity at 69/60 °F	0.830	ĺ			ASTM D-1298
Color	}	}			ASTM D-1500
Cost \$/gal		from supp	lier		-
Availability	Proprieta		L		-

Determinations made at atmospheric pressure, unless noted.

Fluid Code F

Suggested Uses and Possible Limitations

Fluid Code F has a low atmospheric pressure viscosity for a general-purpose petroleum lubricant over a sustained time period. Its corrosion-inhibiting properties are moderately good for both ferrous and nonferrous metals. It is flammable. Initial dielectric properties are good, but additional information relating to electrical applications is lacking.

(Petroleum	Base Fluid	d)		
M. D. D. D. D. D. D. D. D. D. D. D. D. D.				1	Mc thorf
Viscosity, centistokes, at:	55° F	100" 1	1, 0, E		
C paid		100 1	 	1	
3,000 pary		1			See NSIDL
5,000 paig			1		Annapolis Report
5,000 psig			1		M' TLAB
10,000 paig					_
15,000 psig			1		-
20,000 psig					-
		1			
				}	1
			}		
		1	1		
Viscosity, centistokes, at 100° F,	4.68		İ		
Viscosity, centistokes, at 210° F.				İ	ASTM D=1+4+
C paig					
Viscosity Slope, ASTM	0.836		l		
Lubricating Ability					
4-Ball Wear Test, 30 min, 50° C,	ļ				Fed. Method file.
52100 steel, average scar dia.,	ļ		1		(rodified)
mm:					
1 kg 3 kg	ł				-
5 kg		}			
<i>y</i> ^ 9					Ì
		1	İ		
			l		
	ļ	İ	İ		
Corrosion Protection	ļ			į	9
Stirred Kust Test, 10% seawater,			1	1	ASTM D-665
140° F, 2 days	Pass				
On-Off Rust Test, 50% seawater,	Fail	Ì	1		See Chapter 1
140° F, 30 days	1011				Test C-5
Ambient Pressure, coupon				1	See Chapter 1
stirred, corrosion test, weight			1		Test C-1
change, mg			•	ļ	
Copper	- 0.5			İ	-
Stainless Steel, 316	- 0.2		1	}	-
Copper-Nickel (70-30) Aluminum, QQ-A-250-45	- 0.4		1		-
Phosphor-Branze	- 0.2	1	1		-
Steel, galvanized	- 8.0		ļ		-
Steel, 1009	- 0.3		1	ļ	~
Aluminum, QQ-A-250-11	- 0.2				-
Bronze	- 3.7			İ	-
Monel	- 0.3	1			-
Silver Base Brazing Alloy	- 0.2	i	1		1
20,000 PSIG Pressure-Cycled	1				See Charter.
Corrosion Test (l€ seawater),	-	1			Test C-7
weight change, mg		1			
Insulated Specimens: Copper				İ	_
Stainless Steel, 316				İ	_
Copper-Nickel (70-30)			1		_
Aluminum, QQ-A-270-4b				i	-
Phosphor-Bronze	1		!		-
Stee! galvanized	1			:	-
Steel, 1009			ì	F	-
Aluminum, 20-A-190-11	!	; ;	:	:	-
91.0016			1		-
M = = = 1	i	i	Ì	i	1 -
Monel Silver Base Bluzing Alloy	}		1	•	*

				·	,
Carried Dentagation (days)	1		1		Method
Corrosion Protection (Con')	İ	1	ì		1
Electrically Coupled Specimens:		l	•		l -
Copper-Aluminum, QQ-A-C50-11	i	ł	İ	1	1 -
Aluminum QQ-A-C5C 4B'-		1	1		1 -
Copper-Nickel (70-30)	i `	1	1	i	
Mone I - Bronze	ĺ	l	1	ì	
Stainless Steel (516) -	1	i	1	<u> </u>	j _
Phosphor-Buonze	1		l		· ·
Silver Base Brazing Alloy -		[Į	}	
Steel, 2004				i	
•	i	[[
Aluminum 00-A-250-1: -	i			1	ļ -
Bronze			j		
Aluminum QQ-A-250-4b -			ļ	İ	-
Steel, 1009			ł		
20,000 PSIG Stirred Corrosion					See Chapter ?
Test, weight change, mg	ĺ		ł		Test C-4
Insulated Specimens:			l	}	
Copper	İ	٠.		ľ	l _
Stainless Steel, 315		İ	i		i
Copper-Nickel (70-50)		ì	1	l	١ ـ
	ľ		i	[1 _
Aluminum, QQ-A-250-4b			}	i	-
Phosphor-Bronze				Į	-
Steel, galvanized	1	l	!		•
Steel, 1009					i -
Aluminum, QQ-A-250-11			J	1	-
Bronze				ļ	! -
Monel			i		l <u> </u>
Silver Base Brazing Alloy			ļ		l _
				ŀ	<u> </u>
Electrically Coupled Specimens:			1		
Copper-Aluminum, QQ-A-250-11			i	!	. -
Aluminum, QQ-A-250-4t -					i -
Copper-Nickel (70-30)			1		
Monel-Bronze		Í	1	ļ .	-
Stainless Steel (516) -			1	ł	-
Phosphor-Bronze	1		1	ĺ	•
Silver Base Brazing Alloy -			l		l <u>-</u>
Steel, 1009	,		i	! !	
·	1		i		
Aluminum, QQ-A-250-11 -			1		-
Bronze	l		1		1
Aluminum, QQ-A-250-4b -	!	!	1	1	-
Steel, 1009	ĺ	i	ļ		
Pump Test	•		1		Proposed military
Average Whight Loss, mg			ļ		specification for
Steel Gears			Í		sea-water emulsi-
i e e e e e e e e e e e e e e e e e e e					fying oils
Bronze Bushings	1		i	1	-,,5
Corrosion Coupons, weight loss,	1		i		1
each, mg/cm ²			!	ļ	
Copper	<u> </u>		ì		-
Aluminum	ļ		l		-
Steel, galvanized			ŀ		-
Steel, 1009			I		-
Silver Base Brazing Alloy	Ì		I		l -
Dielectric Properties			1		ASTM D-1169 (mod-
			I		ified). See Chap-
Resistivity, 75 °F, ohm-cm:	1.2×10 ¹⁴		I		ter 2. Test E-1
As-Received	1.5×10				
With Sea-Water Contamination:			i		Chapter 2
0.1≸ by volume	i '		Į.		Test E-5
0.5% by volume					-
2.0% by volume			Ţ		-
With Carbon Contamination:			l		Chapter 2
0.1% wt/vol.			l		Test E-6
0.25% wt/vol.			ł		
					_
0.5% wt/vol.	<u> </u>	L		L	

					
Dielectric Properties (Cont)		1	1		Method
After 50,000 Electric Ares	1	1	ł	1	
	1		1		See Chapter ?
(makes and breaks) at 90	1				Test E-7
volts, 10 amperes, resis-	j	1	1	1	1
tive load	Ì	İ			ì
Not filtered	}])		i _
Filtered		1			-
Solids generated, gram	į.				1 -
Dissipation Factor, 75 *P.	ł	ł	ł	I	1
				-	See Chapter ?
As-Received	0.7	Ì		1	Test E-2
With Sea-Water Contamination:	ļ	j.	J	J	See Chapter 2
0.1% by volume			}		Test E-
0.5% by volume					
2.0% by volume		Í	Î	İ	1
With Carbon Contamination:		Ì	l l	ļ	
0.10% wt/vol.	ł	1	ł	ł	See Chapter 2
0.25% wt/vol.	1				Test E-6
	Į		i		 -
0.º0% wt/vol.	1	1	ļ	1	1 -
After 50,000 Electric Arcs		1	1	1	1
(makes and breaks) at 90			1		
volts, 10 amperes, resis-	ſ	í	1		1
tive load	1	1	1	ı	1
Not filtered	1	1	1		1
	ł	1	1	1	-
Filtered	ı	1	1	1	-
Solids generated, gram	!	1	1		-
Dielectric Breakdown Voltage,	1	1	1		ASTM D-877 (mod-
0.05-inch gap, 75 °F, kv		İ	1	1	ified). See Chap-
As received	24.6	1	i	ĺ	ter 2. Test E-3
With sea-water contamination:		ļ			Chapter 2
0.1% by volume		i	1		- ,
0.5% by volume	1	1	1		- Test Σ-5
- ·	1		j		-
2.0% by volume	1	i .	1		-
With carbon contamination:	1				See Chapter 2
0.10% wt/vol.			1		Test E-6
0.25% wt/vol.	Í	1		Í	
0.50% wt/vol.		1	İ		1 [
After 50,000 electric arcs	i	Į.			-
(makes and breaks) at 90	i	Ĭ	ľ		1 1
				1	1
volts, 10 amperes, resis-	J	J	j	1]
tive load	1	1			i I
Not filtered	1	1			l _
Filtered	1	1	ĺ	1	1
Solids generated, gram	1	1	1	ł	1 = 1
Contact Life, silver-cadmium, 50	1	1	1	1	
	1	ł	1	1	See Chapter 2
volts, 10 amperes, resistive	1	I	I	1	Test E-8
load, 6000 psi, 65°-85° F	J	J	J)]
Number of tests	ļ	1		i	-
Operations to failure (range)		Į.	1		
Emulsion Stability	1	1	1		
Paddle Test, after 1-hour set-	1	1	[ASTM D-1401
tling:	I	l	i	1	United Beliefet
-	1 40	į	l	i	, 1
Oil, ml	40]] -
Emulsion, ml	j 8	J]	J] -
Water, ml	32	l	I	I	-
Electric Probe Test, time for	İ		I	I	See Chapter 2
water separation, min	•	Ī	[Test E-4
Material Compatibility Static 20KPSI	į	İ	ĺ	1	See Chapter 2
Butyl	1	İ	1	1	· ·
Buna N	ł		ł	l	Test C-3
			1	i	-
Viton B			l	l .	-
Ethylene-Propylene					[-]
Tetrafluoroethylene (Teflon)				1	l -
Neoprene					_
Thiokol			ĺ	1	_
Silicone			Í		-
,			ł	}	-
Fluorosilicone			L	1	

	1	T	i		Mr. 13 :
Volatility					-
Toxicaty	Petroleur	i	[
Density, grams, cubic centimeter, at:	1	100 F	110 1		
(, '811]		Ī	Dec Builds
4,000 para	į	ļ			Kintaga 1
, 000 best	1				NAVIAE /
3.000 Part]			
10,000 bart		!			
Tr, coc para	j	1			
70,000 par4	37 F T				
isothermal compressibility, w lame decrease, , at:	F	100 F	10.0		
	į.	i		1	See MaisDL
4,000 ps.q					Annape 1: Proper
6.000 psrd	l	ł			MATLAF C
8.900 psig					
10,000 psiq		ł	i		
15,000 psiq					
20,000 psig	1				
Chemical Stability	·		<u></u>		
Oxidation Stability Test, 203° F.	1000+	·			ASTM D= 447
hours to failure					
Oxidation Stability Test, 250° F	1	J			Ted. Mcthod 17 "
Hydrolytic Stability Test				1	Military special -
Specimen change, mg					cation ElL-H-
Specimen appearance	1				1.445,7B
Fluid acid number increase,	}				-
mg KOH/gram fluid					
Water acidity, mg KOH)	ļ			-
Insolubles,					-
Thermal Stability Test	ļ				-
Fire Resistance Flash Point, °F					ASTM D=3
Fire Point, F	300	,			ASTM D=1
Autogeneous Ignition Temperature, of	300				ASTM D-21
High-Pressure Spray Combustor	1				See MLL Resert
Minimum spontaneous ignition					31/66 of March
temperature, °F					1967
Minimum reaction temperature,					-
°F	!				
No indication of fire, °F	!				-
Maximum pressure change, psi	1				-
Lowest temperature of maximum	ļ				-
pressure change, °F	1 1		l		
Temperature range explored, "F		1	i		-
Miscellaneous Properties Pour Point, F	1 1				X 2 may 15 25
Foaming Tendency, 75° F			ì		ASTM D-27 ASTM D-892
Foam after 5-minute aeration,			Ì		BOIN D-CJE
ml	1 1		İ	ł	
Time out, minutes				i	_
Foam after 10 -minute settling,	{		l	ĺ	-
ml					
Neutralization Number, mg KOH/gram	0.08	ĺ	ſ	ĺ	ASTM D-374
Water Content, 5 by weight	0.016		ļ		ASTM D-1744
Neutrality, qualitative			1		Fed. Method 5101
Contamination	ļ		}		-
Number and size of particles and					SAE Method ARP-
fibers in 100-ml fluid				1	598
25-100 micrometers 100-500 micrometers	ļ /		}		_
over 500 micrometers					_
particles over 250 microm-		İ]	_
eters except fibers (length	ļ]
ten times diameter)	[
Pavimetric Value, mg/100 ml					SAE Method ARe. 789
Specific gravity at 71/60 °F	0.832		}		ASTM D-1298
Color	1				ASTM D-1500
Cost /gal	Available	from sup	lier	Ţ	-
Availability	Proprieta	ry l			

¹ eterminations made at atmospheric pressure, unless noted.

Fluid Code G

Suggested Uses and Possible Limitations

The atmospheric pressure viscosity of Fluid Code G suggests that it could be a general-purpose petroleum fluid. Its corrosion-inhibiting properties are moderately good for both ferrous and nonferrous metals. Initial dielectric properties are good, but additional information relating to electrical applications is lacking.

Fluid Code G(1)

Viscometric Properties	
Viscosity, centistokes, at: 50° F 100° F	
Company See NSROL Annapolis Report RATIAB 500 See NSROL Annapolis Report RATIAB 500 RATIAB 50	
See NSIGL Annapolis Report	
9,000 pst.) 8,000 pst.) 10,000 pst.) 11,000 pst.) 12,000 pst.) 20,000 pst.) 20,000 pst.) 20,000 pst.) 20,000 pst.) 21,000 pst.) 21,000 pst.) 22,50 23,50 24,50 25,50 25,50 26,50 21,00 steel, average scar dia., mm: 1 kg 2 kg 5 kg 5 kg Corrosion Protection Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, 2 days Test C-5	
### ##################################	
10,000 psiq 15,000 psiq 20,000 psiq Viscosity, centistokes, at 100° F. Viscosity, centistokes, at 210° F. 0 psiq Viscosity Slope, ASTN 0.823 Lubricating Ability 4-Ball Wear Test, 30 min, 50° C. 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg	
15,000 psiq	
Viscosity, centistokes, at 100° F, 10.80 Viscosity, centistokes, at 210° F, 2.50 O psig Viscosity Slope, ASTM Lubricating Ability 4-Ball Mear Test, 30 min, 50° C, 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg 5 kg Corrusion Protection Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, 2 days	
Viscosity, centistokes, at 100° F. Viscosity, centistokes, at 210° F. O psty Viscosity Slope, ASTM Libricating Ability 4-Ball Wear Test, 30 min, 50° C, 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg - 5 kg - Corrosion Protection Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, D days Test C-5	
Viscosity, centistokes, at 210° F, 2.50 O psig Viscosity Slope, ASTM Lubricating Ability 4-Ball Wear Test, 30 min, 50° C, 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg	
Viscosity, centistokes, at 210° F, 2.50 O psig Viscosity Slope, ASTM Lubricating Ability 4-Ball Wear Test, 30 min, 50° C, 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg	
Viscosity, centistokes, at 210° F, 2.50 O psig Viscosity Slope, ASTM Lubricating Ability 4-Ball Wear Test, 30 min, 50° C, 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg	
Viscosity, centistokes, at 210° F, 2.50 O psig Viscosity Slope, ASTM Lubricating Ability 4-Ball Wear Test, 30 min, 50° C, 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg	
Viscosity, centistokes, at 210° F, 2.50 O psig Viscosity Slope, ASTM Lubricating Ability 4-Ball Wear Test, 30 min, 50° C, 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg	
Viscosity, centistokes, at 210° F, 2.50 O psig Viscosity Slope, ASTM Lubricating Ability 4-Ball Wear Test, 30 min, 50° C, 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg	
Viscosity, centistokes, at 210° F, 2.50 O psig Viscosity Slope, ASTM Lubricating Ability 4-Ball Wear Test, 30 min, 50° C, 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg	
O psig Viscosity Slope, ASTN Lubricating Ability 4-Ball Wear Test, 30 min, 50° C, 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg	
Unbricating Ability 4-Ball Wear Test, 30 min, 50° C, 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg	
Lubricating Ability 4-Ball Wear Test, 30 min, 50° C, 52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg - 5 kg Corrosion Protection Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, D days Ped. Nethod 69 (modified) ASTN D-665 Pass Pass On-Off Rist Test, 50% seawater, 140° F, D days Test C-5	
52100 steel, average scar dia., mm: 1 kg 3 kg 5 kg - 5 kg Corrosion Protection Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, A days See Chapter ? Test C-5	
Test C-5	U.S
1 kg 3 kg 5 kg 5 kg Corrosion Protection Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, A days	
Corrosion Protection Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, A days Corrosion Protection ASTN D-665 Pass On-Off Rist Test, 50% seawater, 140° F, A days Test C-5	
Corrusion Protection Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, A days Test C-5	
Corrusion Protection Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, 140° F, A days Corrusion Protection ASTM D-665 Pass Fail See Chapter 7 Test C-5	
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, Fail See Chapter ? 140° F, A days ASTN D-665 Pass Fail See Chapter ? Test C-5	
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, Fail See Chapter ? 140° F, A days ASTN D-665 Pass Fail See Chapter ? Test C-5	
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, Fail See Chapter ? 140° F, A days ASTN D-665 Pass Fail See Chapter ? Test C-5	
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, Fail See Chapter ? 140° F, A days ASTN D-665 Pass Fail See Chapter ? Test C-5	
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, Fail See Chapter ? 140° F, A days ASTN D-665 Pass Fail See Chapter ? Test C-5	
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rist Test, 50% seawater, Fail See Chapter ? 140° F, A days ASTN D-665 Pass Fail See Chapter ? Test C-5	
140° F, 2 days On-Off Rist Test, 50% seawater, Fail See Chapter ? 140° F, A days Test C-5	
On-Off Rist Test, 50% seawater, Fail See Chapter ? 140° F, \(\sigma\) days Test C-5	
140° F, A days Test C-5	
stirred, corrosion test, weight Test C-1	
change, mg	
Copper -0.1	
Stainless Steel, 316 +0.2 -	
Copper-Nickel (70-30) -0.1 -	
Aluminum, 2Q-A-250-4b +0.2 -	
Phosphor-Bronze 0	
Steel, galvanized -6.6	
Steel, 1009 +0.5	
Aluminum, QQ-A-250-11 +0.2	
Mone) +0.1 -	
Silver Base Brazing Alloy -0.7	
20,000 PSIG Pressure-Cycled See Chapter 2	
Corrosion Test (1% seawater), Test C-2	
weight change, mg	
Insulated Specimens:	
Copper	
Stainless Steel, 316	
Copper-Nickel (70-30)	
Aluminum, QQ_A_250_4b Phosphor_Bronze	
Steel, galvanized	
Steel, 1009	
Aluminum, QQ-A-250-11	
Bronze	
Monel -	
Silver Base Brazing Alloy	

			T	·	7
	1]	1		Method
Corrosion Protection (Cont)	J	1		1	
Electrically Coupled Specimens:	1	1		Ī	-
Copper-Aluminum, QQ-A-250-11	.	}			l - I
Aluminum QQ-A-250-4b -	1	1			l
Copper-Nickel (70-30)	1	1	[[[
Mone 1 - Pronze	ł	} .			
The state of the s	1	1		ļ	-
Stainless Steel (516) -]	ł	ł	į	-
Phosphor-Bronze		•	1		
Silver Base Brazing Alloy -		ł	1		-
Steel, 1004	[,	1	1
Aluminum QQ-A-250-11 -	1		1	Ì	j <u> </u>
Bronze	ł	1	1	1	1
Aluminum QQ-A-250-4b -	1	ļ	1		
Steel, 1009	1	!			l - 1
		1 .	l	l	!
20,000 PSIG Stirred Corrosion	(10% seaw	ter)	į	!	See Chapter ?
Test, weight change, mg		1	í		Test C-4
Insulated Specimens:		1	1		
Copper	-0.5				_
Stainless Steel, 316	0	i	1	i	1 - 1
Copper-Nickel (70-30)	١٥				_
Aluminum, QQ-A-250-4b	1 -	1		1	=
	-0.1	Į.		1	-
Phosphor-Bronze	-0.1	i	1	Į	, - <u> </u>
Steel, galvanized	-0.3	!			-
Steel, 1009	0	1	1		i - I
Aluminum, QQ-A-250-11	0		1		-
Bronze	+0.1	İ	ł		1 - 1
Monel	0		1		' !
Silver Base Brazing Alloy	-0.6	1			1 _
Electrically Coupled Specimens:		1	1		-
Copper-Aluminum, QQ-A-250-11			-		1
	1-1.3 -0.5	j	}		i - ;
Aluminum, QQ-A-250-4b -		1			-
Copper-Nickel (70-30,	-0.3 -0.1	İ			[
Mon-1-Bronze	0 +0.3				-
Stainless Steel (316) -	1	ł			-
Phosphor-Bronze	0 -0.1	[1		í 1
Silver Base Brazing Alloy -	* **-		İ		l <u>-</u> 1
Steel, 1009	06 03	ì	<u> </u>		1
	-0.6 -0.3	[l		}
Aluminum, QQ-A-250-11 -	}				-
Bronze	-0.1 +0.3				!
Aluminum, QQ-A-250-4b -	ļ		1		i - I
Steel, 1009	-0.1 0				1
Pump Test			[Proposed military
Average Weight Loss, mg	1				specification for
Steel Gears	1	1			sea-water emulsi-
Bronze Bushings	8		1		fying oils
. · · · · · · · · · · · · · · · · · · ·	1	}			Tyring Olls
Corrosion Coupons, weight loss,	-				
each, mg/cm²	İ				1
Copper	0.01				-
Aluminum	0.03				-
Steel, galvanized	0.01				-
Steel, 1009	0.01				_
Silver Base Brazing Alloy	0.02	1			1 _ 1
Dielectric Properties	V. 02				ASTM D-1169 (mod-
	_ 13				
Resistivity, 75 °F ohm-cm:	8.0×10 ¹³				ified). See Chap-
As-Received	J				ter 2. Test E-1
With Sea-Water Contamination:					Chapter 2
0.1% by volume					Test E-5
0.5% by volume					_
2.0% by volume					
With Carbon Contamination:					Chapter 2
0.1% wt/vol.					Test E-6
0.1% wt/vol.					Lest E-C
					-
0.5% wt/vol.					

		T -1		T	Method
Dielectric Properties (Cont)	j			}	
Atter 50,000 Electric Arcs	ŀ	1		1	See Chapter C
(makes and breaks) at 90	1	1		(Test E-7
volts, 10 amperes, resis-	1	j		ł	1
tive load Not filtered	ł	1			1_
Filtered	1	1 1			1.
Solids generated, gram	l .	1 1			\ <u>-</u>
Dissipation Factor, 75 °F. 3		1 1			See Chapter C
As-Received	0.8]		ĺ	Test E-2
With Sea-Water Contamination;	1	1 1		Ì	See Chapter ?
0.1% by volume	ł	1 1			- Test E-5
0.5% by volume		1 1		1	-
2.0% by volume	ĺ	1 1		į	1 -
With Carbon Contamination:		i I			See Chapter ?
0.10% wt/vol.		!!!			Test E-6
0.25% wt/vol.		1		i	-
0.50% wt/vol.		1 1			-
After 50,000 Electric Arcs	1	!			4 ·
(makes and breaks) at 90	1	1			İ
volts, 10 amperes, resis- tive load	}	, <u> </u>	1		1
Not filtered		1 1			_
Filtered	1	! !	1		\ -
Solids generated, gram		! !		į	-
Dielectric Breakdown Voltage,	İ	1			ASTM D-877 (mod-
0.05-inch gap, 75 °F, kv		1 1	'		ified). See Chap-
As received	29.9	1			ter 2. Test E-3
With sea-water contamination:	1	1			See Chapter ?
0.1% by volume		ļ i			Test E-5
0.5% by volume]	1	,		-
2.0% by volume	ł	1 1		1	
With carbon contamination:		1 1		Į	See Chapter 2
0.105 wt/vol.	l	1 1		į	Test E-6
0.25% wt/vol.	1	!!!		Į	-
0.50% wt/vol.		1 1		<u> </u>	· -
After 50,000 electric arcs	ţ	1 1		İ	1
(makes and breaks) at 90					1
volts, 10 amperes, resis- tive load]	1 1			
Not filtered	1	1			\ _
Filtered	İ	1 1			1 -
Solids generated, gram	1	1]	i _
Contact Life, silver-cadrium, 50		!!!			See Chapter 2
volts, 10 amperes, resistive	1	1		1	Test E-3
load, 6000 psi, 65°-85° F		[[
Number of tests	}			}	} -
Operations to failure (range)	1	1 1			
Emulsion Stability	1	į l		ļ	
Paddle Test, after 1-hour set-	1	1 1		ł	ASTH D-1401
tling:	l	i l			
Oil, ml	38	; [i	-
Emulsion, ml	30	1 1			-
Water, ml	12	1 1			See Chapter 2
Electric Probe Test, time for	Į.				Test E-4
water separation, min	!	, ,]	See Chapter 2
Material Compatibility Static 20KPSI	1	; 1			
Butyl	1	, [į		Test C-3
Buna N	1				1 -
Viton B Ethylene-Propylene	İ	1 1	i		
Tetrafluoroethylene (Teflon)]			1 -
Neoprene	1	[]	:		-
Thiokol	I	1			1 -
Silicone	1	j			-
Fluorosilicone		<u> </u>		l	1 -

Volatility) i		Method
	Bet roleus		1		
Density, grams/cubic centimeter, at:	Petroleum 35 F	100 F	† ~150 * 1:	- · · · - ·	† • • • • • • • • • • • • • • • • • • •
(psiq			1		See NSRDL
4,000 psiq			! [Annapolis report
5,000 paig			1		MATLAB 310
8,000 psig			1		
10,000 psig			1		
16,000 ps 19			1		
70,000 psiq		!	1 1		
Isothermal Compressibility, volume	55° F	100° F	† 150 ° F †	• • • • • • • • • • • • • • • • • • • •	* · · · · · · · · · · · · · · · · · · ·
decrease, %, at:			 		Sec NSPDL
0 psig]		Annapol s Peport
3,000 psiq			1		MATLAB 311
9,000 psiq					
8,000 psig			1		
10,000 psig] [
15,000 psig					
20,000 psig					
Chemical Stability			 		
Oxidation Stability Test, 203° F.	1000+				ASTM D=94.
hours to failure	10007				
Oxidation Stability Test, 250° F					Fed. Method 5707
Hydrolytic Stability Test			1 [Military specifi-
Specimen change, mg			1 1		cation MIL-H-
Specimen appearance	!		1 1		19457в
Fluid acid number increase,					1 2 2 2 2
mg KOH/gram fluid					1
Water acidity, mg KOH	ļ				1_
Insolubles, %	[1 _
Thermal Stability Test					_
Fire Resistance	j				
Flash Point, °F	300				ASTM D-98
Fire Point, °F	325		}		ASTM D-0
Autogeneous Ignition Temperature, F					ASTM D-2155
High-Pressure Spray Combustor	ļ		1		See MEL Report
Minimum spontaneous ignition			1 1		31/66 of March
temperature, °F			1		1967
Minimum reaction temperature,			1		1 -
°F	į į				
No indication of fire, °F					1 -
Maximum pressure change, psi					i -
Lowest temperature of maximum			1		_
pressure charge, °F	j '				1
Temperature range explored, "F					_
Miscellaneous Properties					+
Pour Point, F	<-45				ASTM D-97
Foaming Tendency, 75° F	1		1 :		ASTM D-802
Foam after 5-minute seration,					-
m1			1		
Time out, minutes					_
Foam after 10-minute settling,					-
ml					
Neutralization Number, mg KON/gram	0.10			•	ASTM D-374
Water Content, % by weight	0.005				ASTM D-1744
Neutrality, qualitative	1 7.00)				Fed. Method '101
Contamination	- I				_
Number and size of particles and	ļ		!		SAE Method ARP-
fibers in 100-ml fluid					598
25-100 micrometers					-
100-500 micrometers]		_
over 500 micrometers					-
particles over 250 microm-	1				-
eters except fibers (length					
ten times diameter)	1				
Gravimetric Value, mq/100 ml					SAE Method ARP - 78
	0.872				1
Specific Gravity at 70/60 °F Color	0.012				ASTM D-1298 ASTM D-100
Cost \$/gal	availahl	from su	bolier		-
	propriet		qr: 1		1

Availability proprietary

Determinations made at atmospheric pressure, unless noted.

Fluid Code H

Suggested Uses and Possible Limitations

The atmospheric pressure viscosity of Fluid Code H would lead to the prediction that it would not be suitable for hydraulic systems or lubrication uses at more than 4000-foot depth. properties are moderately good for both ferrous and nonferrous metals.

	(Petroleum	Base Flui	.d)		
		1	-		Method
Viscometric Properties					
Viscosity, centistokes, at:	35° F	100° F	1.0° F		
0 paig 3,000 paig				ļ	
5,000 paig	1	ł	ł	1	See NSRDL
8,000 parg	į		E		Annapolis Report
10,000 parg				ł	MATIND 10
15,000 pmig	{		İ		
20,000 psiq	ļ	į			
	j l	1			
	1	1			
	1		ŀ		
[[ĺ			
	ŀ	İ			
Viscosity, centistokes, at 100 °F,	34.0	ł			
Viscosity, centistokes, at 210° F.		i			ASTM D-44"
O paiq	1 9.71				י דרייע מו פא
Viscosity Slope, ASTM	0.764			1	
Lubricating Ability	71177	†		·	
4-Ball Wear Test, 30 min, 50° C,	}	1			Fed. Method 650
52100 steel, average scar dia.,		[(modified)
mm:	[
1 kg					-
3 kg					-
5 k g					-
	[['	
	!]			
]				
Corrosion Frotection Stirred Rust Test, 10% seawater,	_				ASTM D-665
140° F, 2 days	Pass				ASIM D-005
On-Off Rust Test, 50% seawater,	Pail				See Chapter 2
140° F. 30 days	Fall				Test C-5
Ambient Pressure, coupon		1			See Chapter ?
stirred, corrosion test, weight					Test C-1
change, mg					
Copper	+2.0				-
Stainless Steel, 316	+0.1		j		-
Copper-Nickel (70-30)	+0.1				-
Aluminum, QQ-A-250-4b	+0.3	(ļ		-
Phosphor-Bronze Stee), qalvanized	+0.2				
Steel, 1009	-0.9 +0.5				1.
Aluminum, QQ-A-250-11	+0.5				
Bronze	+0.2	į l			-
Mone1	+0.1				_
Silver Base Brazing Alloy	-0.3		İ		
20,000 PSIG Freasure-Cycled	-				See Chapter :
Corresson Test (1% seawater),]			Test C-2
weight change, mg			İ		1
Insulated Specimens:			į		
Copper Stainless Steel, 316					-
Copper-Nickel (70-30)			1		-
Aluminum, 20-A-250-4b		1			
Phosphor-Bronze			1		
Steel, galvanized					-
Steel, 1009			1		-
Aluminum, QQ-A-250-11			ì		-
Bronze	!		İ		-
Monel		1			-
Silver Base Brazing Alloy					

			1		Method
Corrosion Protection (Cont)		1	-		[
Electrically Coupled Specimens:		ı	1		1 -
Copper-Aluminum, QQ-A-250-11		į.		-	-
Aluminum QQ-A-250-4b -		l	i	Į	-
Copper-Nickel (70-30)	1	1	l	ļ	Į.
Monel-Bronze]	!	}		-
Stainless Steel (516) -	•	1	1	ļ	-
Phosphor-Bronze	l	į			·
Silver Base Brazing Alloy -			1		-
Steel, 1004	1	l	į	l ·	
Aluminum QQ-A-250-11 -	l	1	l	l	-
Bronze		į	ļ		
Aluminum QQ-A-250-4b -		l	į		-
Steel, 1009					_
20,000 PSIG Stitred Corrosion		[l		See Chapter 2
Test, weight change, mg		l	i .	ļ	Test C-4
Insulated Specimens:			ł		
Copper			ì		-
Stainless Steel, 316		ţ			<u> </u>
Copper-Nickel (70-30)		Į	l		-
Aluminum, QQ-A-250-4b				1	-
Phosphor-Bronze			i		-
Steel, galvanized]	l		-
Steel, 1009		ł	ł		-
Aluminum, QQ-A-250-11		1	1		-
Bronze		į	Į.		-
Monel			İ		-
Silver Base Brazing Alloy		}	Ì		-
Electrically Coupled Specimens:		[ĺ		
Copper-Aluminum, QQ-A-250-11		}			-
Aluminum, QQ-A-250-4b -		Į	Į		-
Copper-Nickel (70-30)					
Monel-Bronze					-
Stainless Steel (316) -		}			-
Phosphor-Bronze		ì	1		
Silver Base Brazing Alloy -		l			-
Steel, 1009		1	1		
Aluminum, QQ-A-250-11 -		ĺ			•
Bronze		ĺ			:
Aluminum, QQ-A-250-4b -		l	[-
Steel, 1009			j		
Pump Test]		Proposed military
Average Weight Loss, mg					specification for
Steel Gears					sea-water cmulsi-
Bronze Bushings			į		fying oils
Corrosion Coupons, weight loss,]			
each, mg/cm ²		İ			
Copper					-
Aluminum	'				-
Steel, galvanized					•
Steel, 1009					_
Silver Base Brazing Alloy					•-
Dielectric Properties					ASTM D-1169 (mod-
Resistivity, F, ohm-cm:		l			ified). See Chap-
As-Received			ĺ		ter 2. Test E-1
With Sea-Water Contamination:					Chapter 2
0.1% by volume					Test E-5
0.5% by volume		ļ			
2.0% by volume					_
With Carbon Contamination:					Chapter 2
0.1% wt/vol.					Test E-6
0.25€ wt/vol.					- 1440 5-0
0.5% wt/vol.					-

Dielectric Properties (Cont)	Ī	-{			Method
After 50,000 Electric Ares	1	1	1	ļ	
Arter 50,000 Electric Ares		1			See Chapter 2
(makes and breaks) at 90	1	i	ļ		Test E-7
volts, 10 amperes, resis-					
tive load	ļ	1	l	1	
Not filtered	j	j	J		
Filtered	1	1			-
Solids generated, gram	1	1	1	j	! -
Dissipation Factor, F, %				ļ	See Chapter ?
As-Received	j	1		ļ	Test E-2
With Sea-Water Contamination:	ļ	j	j	ļ	See Chapter ?
0.1% by volume	-				Test E-5
0.5% by volume	J		J		-
2.0% by volume	ļ		-		~
With Carbon Contamination:]	1	į		See Chapter ?
0.10% wt/vol.		-			Test E-G
0.25% wt/vol.	}]	j	j	_
0.50% wt/vol.					-
After 50,000 Electric Arcs			1		
(makes and breaks) at 90	1	j	1		
volts, 10 amperes, resis-	1		ĺ	1	
tive load	1	1			
Not filtered		•		ĺ	_
Filtered			j]	_
Solids generated, gram			İ		_
Dielectric Breakdown Voltage,	1	1	1		ASTM D-877 (mod-
0.05-inch gap, F, kv	7	ļ	i		ified). See Chap-
As received	İ	i	1	1	ter 2. Test E-3
With sea-water contamination:		1			See Chapter 2
0.1% by volume	1	1	1	1	Yest E-5
0.5% by volume	1	1	1	!	
2.0% by volume		i		1	_
With carbon contamination:	į	1	1		See Chapter 2
0.10% wt/vol.	İ	1			Test E-6
0.25% wt/vol.	l		1		1625 5-0
0.50% wt/vol.	1	ł	1		i "
After 50,000 electric arcs	1	1	1		- 1
(makes and breaks) at 90	1	1	1		
volts, 10 amperes, resis-	1		Ī		
tive load	į.				
Not filtered		Į.			
Filtered		ł	ł .		-
- · - · · · · · · · · · · · · · · · · ·	ļ	1	1		-
Solids generated, gram		Į			-
Contact Life, eilver-cadmium, 50	į.		1	ļ	See Chapter 2
volts, 10 amperes, resistive]	1			Test E-5
load, 6000 psi, 65°-85° F Number of tests	1	ł	1		1
	1	1	1		- 1
Operations to failure (range)			1		<u> </u>
Emulsion Stability	ł	ì	1		
Faddle Test, after 1-hour set-	Ì				PSTM D-1401
tling:	,,,	l	1 1		1
Oil, ml	40	1		J	- 1
Emulsion, ml	0	l	1		- 1
Water, ml	40	1]]		- 1
Electric Probe Test, time for		l			See Chapter 2
water separation, min		J		j	Test E-4
Material Compatibility Static 20KPSI]	j j	j	See Chapter 2
Butyl		l		l	Test C-3
Buna N		}]	{	-
Viton B		l .] [ĺ	-
Ethylene-Propylene		j)	J	_
Tetrafluoroethylene (Teflon)		l ·		j	- i
Neoprene		J	1	ļ	- 1
Thiokol		l	[1	_
Silicone		1	'[[-
Fluorosilicone		L	<u>l</u>		

The second secon

all property

IJ

[

-1-1-A-11-A-1					Method
Volatility Toxicity	Petrolew	1	l		-
Density, grams/cubic centimater, at:	37.	100° F	150° F		
0 psiq	122	100 -	150 1	i	See NSRDL
5,000 paty	i	ĺ		ĺ	Annapolis Report
5,000 parq	Ì	j			NATLAB 550
	i				ACTION 150
8,000 paig					
10,000 paig			'		
15,000 p#1q 20,000 p#1q					
Isothermal Compressibility, volume	-424-E	100° F	150° F		
decrease, %, at:	<u> </u>		1001		See NSRDL
0 psig				1	Annapolis Report
3,000 psiq	ĺ			•	MATLAB 350
5,000 paid			·		MATILAN 330
• • •			j '		
8,000 psig					
10,000 psig			i		
15,000 paig					
20,000 psig	ļ		ļ		
Oxidation Stability Test, 203° F,	1		}		ASTN 0-943
					ASIR Day 12
hours to failure					
Oxidation Stability Test, 250° F			l		Fed. Method 5308
Hydrolytic Stability Test			l		Kilitary specific
Specimen change, mg			1		cation NIL-H-
Specimen appearance			ļ		19457в
Fluid acid number increase,					-
mg KOH/gram fluid			ĺ		
Water acidity, mg KOH					1 -
Insolubles, \$					-
Thermal Stability Test		•			-
Fire Resistance			i		į
Flash Point, 'F	395				ASTH D-92
Fire Point, °F	445		1		ASTM D-92
Autogeneous Ignition Temperature, F			1		ASTH D-2155
High-Pressure Spray Combustor			[See MEL Report
Minimum spontaneous ignition			1		51/66 of March
temperature, °F			1		1967
Minimum reaction temperature,					 -
•F					i
No indication of fire, "F			1		l -
Maximum pressure change, psi					1 _
Lowest temperature of maximum			1		l _
pressure change, °F	1	İ]		
Temperature range explored, °F	1				! _
Miscellaneous Properties			1		
Pour Point, F					ASTM D-97
Foaming Tendency, 75° F		İ	† •		ASTM D-892
Foam after 5-minute aeration,	1	<u> </u>			
			Į		l -
ml	1				
Time out, minutes	1			·	-
Foam after 10-minute settling,	j				-
ml	ļ		1		3.0mm 5.075
Neutralization Number, mg KON/gram	0.000		ļ		ASTM D-974
Water Content, % by weight	0.002		1		ASTM D-1744
Neutrality, qualitative					Fed. Method 5101
Contamination					
Number and size of particles and	4		1		SAE Method ARP-
fibers in 100-ml fluid			1		598
25-100 micrometers]	l ⁻		-
100-500 micrometers					- ,
over 500 micrometers				{	-
particles over 250 microm-	Ì				-
eters except fibers (length			l		
ter times diameter)	į		1		
Gravimetric write, mg/100 ml	ļ		1		SAE Method ARP-7
Specific gravity at 70/60 °F	0.866	İ			ASTM-D-1298
Color	1		ļ		ASTN D-1500
Cost \$/gal	availabl	from su	plier		
- · · · · · · · · · · · · · · · · · · ·	propriet		1 -	I	1

Determinations made at atmospheric pressure, unless noted.

Fluid Code J

Suggested Uses and Possible Limitations

Fluid Code J, a petroleum oil product, meets the requirements of the United States Pharmacopela (USP) for medicinal mineral oils. It has been used in a deep submergence vehicle as an immersion fluid for nonmoving electrical parts. Field experience has shown that it has failed as a lubricant for electric motors and gears at 1000 psig. It provides no corresion protection. It has satisfactory dielectric properties. Its poor sea-water emulsion stability makes it questionable for use with motors at deep submergence pressures. Although its dielectric properties are good, its relatively high viscosity makes it a questionable choice for other electrical applications at deep submergence pressures.

Fluid Code J(1)

	Petroleum		·/		
Viscometric Properties	[Method
Viscosity, centistokes, at:	55° P	100° F	:50° F		
0 paig					i
3,000 paig					Se≥ NSRDL
5,000 paig	Ī				Annapolis Report
8,000 parg	1				HATLAB 350
10,000 psig					-
15,000 paig					-
20,000 paig					-
	!				<u> </u>
					İ
	l				i
				•	
	1				
Viscosity, centistokes, at 100° P.	44.1				
Viscosity, contistokes, at 210° F,	6.08	į			ASTM D-445
O paig					
Viscosity Slope, ASTM	0.771				·
Lubricating Ability					Fed. Method 6503
4-Ball Wear Test, 30 min, 50° C.	1		}	İ	(modified)
52100 steel, average scar dia.,	1		!		(mourried)
man: 1 kg					l <u>-</u>
i kg 3 kg					_
5 kg	i				-
)	1				
		ĺ			
	-		ĺ		
	İ				
Corrosion Protection					ASTM D-665
Stirred Rust Test, 10% seawater, 140° F, 2 days	B 23				
On-Off Rust Test, 50% seawater,	Fail				See Chapter 2
140° F, 30 days	Fail				Test C-5
Ambient Pressure, coupen					See Chapter 2
stirred, corrosion test, weight					Test C-1
change, mg		ĺ			
Copper	- 8.5				-
Stainless Steel, 316	+ 2.7				-
Copper-Nickel (70-30)	+ 1.3				-
Aluminum, QQ-A-250-4b	+552.1				-
Phosphor-Bronze	- 12.7				-
Steel, galvanized	+ 62.9				1 -
Steel, 1009 Aluminum, <u>QQ</u> -A-250-11	-909.7 +134.9		i		
Bronze	- 10.0	-			l _
Monel	- 2.4				_
Silver Base Brazing Alloy	+ 2.5				1
20,000 FSIG Pressure-Cycled		l			See Chapter 2
Corrosion Test (1% seawater),					Test C-2
weight change, mg					1
Insulated Specimens:					
Copper	ļ				~
Stainless Steel, 316					-
Copper-Nickel (70-30)]			l -
Aluminum, QQ-A-250-4b	1				1.
Phosphor-Bronze]			1 -
Steel, galvanized	1]			1
Steel, 1009					-
Aluminum, QQ-A-250-11 Bronze					_
Monel	1				_
Silver Base Brazing Alloy	1	l	ļ	l	-
Diator Depo Demoning many	4				

<u> </u>	Ţ		T		Mark Comment
i Lournation to the ion (out)	•	ı	l		Method
Corresion Listaction (Cont)	ı	ļ	i		
Electrically Coupled Specimens:		1	Į.	1	-
Copper-Aluminum, QQ-A-250-11					-
Aluminum QQ-A-250-4b -		ł			-
Copper-Nickel (70-30)	1	}]	}	
Monel-Bronze	1	ł		ļ	-
Stainless Steel (516) -	i	1			-
Phosphor-Bronze	Ì	1			
Silver Base Brazing Alloy -	1		ļ		-
Steel, 1004				1	
Aluminum QQ-A-250-11 -		1		į	_
Bronze			1		
Aluminum QQ-A-250-4b -	1				_
Steel, 1009	İ		İ	•	
20,000 PSIG Stirred Corrosion		}	I	ł	See Chapter ?
Test, weight change, mg	1		1		Test C-4
Insulated Specimens:		1	}	i .	1680 0-4
Copper	1	l			
Stainless Steel, 316	1		i		-
]		-
Copper-Nickel (70-30)	1	i	1		-
Aluminum, QQ-A-250-4b	1		1	1	-
Phosphor-Bronze	1		1		-
Steel, galvanized	1		l		-
Steel, 1009	1	1	ļ		-
Aluminum, QQ-A-250-11					-
Bronze	1				-
Monel		ļ		1	-
Silver Base Brazing Alloy	İ	Ì			-
Electrically Coupled Specimens:	1				
Copper Aluminum, QQ-A-250-11					_
Aluminum, QQ-A-250-4b -					-
Copper-Nickel (70-30)	Į				
Monel-Eronza	1				_
Stainless Steel (316) -	1			Ì	_
Phosphor-Bronze	1				
Silver Base Brazing Alloy -	1				_
Steel, 1009					_
Aluminum, QQ-A-250-11 -	ŀ	ŀ			
	1	į			-
Bronze					
Aluminum, QQ-A-250-4b -					-
Steel, 1009		<u> </u>			
Pump Test	1	j			Proposed military
Average Weight Loss, mg		[Ì	specification for
Steel Gears	}			Ì	sea-water emulsi-
Bronze Bushings	ļ				fying oils
Corrosion Coupons, weight loss,					
each, mg/cm ²	1	j :			
Copper		1		ļ	-
Aluminum					-
Steel, galvanized					-
Steel, 1009	1				-
Silver Base Brazing Alloy	1				-
Dielectric Properties			l		ASTM D-1169 (mod-
Resistivity, 80 F. ohm-cm;		1			ified). See Chap-
• ····	12.6×10 ¹⁴				ter 2. Test E-1
As-Received (2) With Sea-Water Contamination:	12.0810	'			Chapter 2
with Sea-water Contamination:	4.4×10 ¹⁴		İ		
0 Est have are 3	1				Test E-5
0.5% by volume	1	į į			-
2.0% by volume	1				
With Carbon Contamination:					Chapter 2
	i		ļ		Test E-6
0.25% wt/vol.	1				-
0.5% wt/vol.					

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Dielectric Properties (Cont)	1			Met hod
After 10,000 Electric Arcs	ı	1		0 0 0
(makes and preaks) at 90	ł			See Chapter 2
volts, 10 amperes, resis-	}	1	ł	Test E-7
tive load				1
Not filtered	1 . 14	ł		1
ł company of the comp	5.4x10 ¹⁴ 2.2x10 ¹⁴			-
Filtered	3.5×10-4]	1	-
Solids generated, gram	1.16	ł i		-
Dissipation Factor, 80 °F, %	J	j		See Chapter ?
As-Received	0.0	1		Test E-2
With Sea-Water Contamination;	0.0	ì	}	See Chapter 2
0.1% by volume	[ſ	[- Test E-5
0.5% by volume	Ì			-
2.0% by volume	[
With Carbon Contamination:	t .			See Chapter 2
0.10% wt/vol.	1		1	Test E-6
0.25% wt/vol.				1 .
0.50% wt/vol.	Ĭ		ĺ	1 - 1
After 60,000 Electric Arcs				1 1
(makes and breaks) at 90	1		1	1
volts, 10 amperes, resis-	1	i		
tive load	1		ł	į i
Not filtered				1
Filtered	0.9	1	1	1 "
Solids generated, gram	0.6		,	-
	1	1	Į	-
Dielectric Breakdown Voltage,				ASTM D-877 (mod-
0.05-inch gap, 80 °F, kv		1	}	ified). See Chap-
As received	27.6	i	ļ	ter 2. Test E-3
With sea-water contamination:	9.0	}		See Chapter 2
0.1% by volume				Test E-5
0.5% by volume				1 -
2.0% by volume]			1 -
With carbon contamination:	i l		j	See Chapter 2
0.10% wt/vol.	1			Test E-6
0.25% wt/vol.	1			-
0.50% wt/vol.				
After 50,000 electric arcs	l i			
(makes and breaks) at 90		ì		
volts, 10 amperes, resis-	i i	l	1	1 :
tive load				1
Not filtered	1 1	l	İ	1 1
Filtered	7.2	1	1	1 - 1
Solids generated, gram	28.6		1	-
	l 1			-
Contact Life, silver-cadmium, 50	}		}	See Chapter 2
volts, 10 amperes, resistive	1	j	ì	Test E-8
load, 6000 psi, 65°-85° r)		ļ	1
Number of tests				-
Operations to failure (range)	}			,
Emulsion Stability]
Paddle Test, after 1-hour set-		j	}	ASTM D-1401
tling:				j
Oil, ml	40		}	-
Emulsion, ml	0	j		_
Water, ml	40		1	-
Electric Probe Test, time for	0.2		i .	See Chapter 2
water separation, min	"-			Test E-4
Material Compatibility Static 20KPSI			1	See Chapter 2
Butyl	l l			Test C-3
Buna N	' !	1	1	1000 0-7
Viton B	ı	1]	-
Ethylene-Propylene	ĺ	1	1	-
Tetrafluoroethylene (Teflon)		1		-
Neoprene	}	1	1	-
Thiokol				- i
Silicone	j	ł	1	-
			1	-
Fluorosilicone		LL		

	T	T	1	1	Method
Volatility	ĺ				-
Toxicity	Petrolew	<u> </u>		L	•
Density, grams/cubic centimeter, at:	2	100° F	11.0 F]	Ĭ
0 psig					See NSKDL
3,000 paig	1		ł		Annapolis Report
5,000 paig	1	ļ		•	MATLAB 550
8,000 psig	1				
10 000 psig		ŀ	ĺ	}	
15,000 paig		ļ	1	•	
20,000 psig	İ	Ĺ	l	1	l
Isothermal Compressibility, volume	35" F	100° F	150° F	J	[
decrease, 5 at:			T	1	See NSRDL
0 psig			ļ	!	Annapolis Report
3,000 psig		1			MATLAB 350
5,000 psig	i	1	}	i	ĺ
8,000 psig	i	Ì		1	
10,000 psig		1	İ		
15,000 psig	i	ļ		İ	
20,000 paig	1	L	L	L	
Chemical Stability					
Oxidation Stability Test, 203° F,	1				ASTM D-943
hours to failure	Ì	l	ļ		
Oxidation Stability Test, 250° F	1	I	[1	Fed. Method 5308
Hydrolytic Stability Test		i			Military specifi-
Specimen change, mg		0.12	<u> </u>		cation MIL-H-
Specimen appearance		Satisfact	orv	l .	19457В
Fluid acid number increase,	1	0	,		_
mg KOH/gram fluid	i		•		
Water acidity, mg KOH	1	0.31			-
Insolubles, %		nil		Į	_
Thermal Stability Test		"		1	-
Fire Resistance		l	Į		
Flash Point, °F	400		1	i	ASTM D-92
Fire Point, °F	435	1		i	ASTM D-92
Autogeneous Ignition Temperature, F	1 100	1			ASTM D-2155
High-Pressure Spray Combustor		ì			See MEL Report
Minimum spontaneous ignition		i		i	31/66 of March
temperature, °F		1	İ		1967
Minimum reaction temperature,			i		_
°F	Ì		ļ		
No indication of fire, °F	1				_
Maximum pressure change, psi					_
Lowest temperature of maximum	1				-
pressure change, °F		į.			
Temperature range explored, "F	1	l	İ		_
Miscellaneous Properties		}	ł	1	
Pour Point, F	-5				ASTM D-97
Foaming Tendency, 75° F	- _ا	I	ł	1	ASTM D-892
Foam after 5-minute aeration,		1		ł	-
ml	}	1		1	
Time out, minutes	1	1			_
Foam after 10-minute settling,	1	1			-
m1	1	1			
Neut Alization Number, mg KOH/gram	0.03				ASTM D-974
Water Content, % by weight	0.005				AS1M D-1744
Neutrality, qualitative	1	İ		ĺ	Fed. Method 5101
Contamination	1	1			•
Number and size of particles and	1	[l]	SAE Method ARP-
fibers in 100-ml fluid	1	1			598
25-100 micrometers	1	[
100-500 micrometers					-
over 500 micrometers	1]	l		<u> </u>
particles over 250 microm-		1			-
eters except fibers (length	1				
ten times diameter)	ļ	1	1		
Gravimetric Value, mg/100 ml	1	[·		1	SAE Method ARP-78
Specific gravity at 69/60 °F	0.868	l			ASTM D-1298
Color			ļ		ASTM D-1500
Cost \$/gal	available	from sup	lier	1	
Availability	proprieta				_
	BATANTTAIN	-	<u> </u>		L

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Fluid Code K

Suggested Uses and Possible Limitations

Fluid Code K meets the requirements of the National Formulary (NF) for medicinal mineral oils. As a petroleum oil product its dielectric properties have not been determined. It has been used as an immersion fluid for nonmoving electric components at depths not exceeding 2000 feet. In one particular instance in the field, it failed as a lubricant for moving parts. It provides no corrosion protection.

Fluid Code K(1) (Petroleum Base Fluid)

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			<u> </u>		Method
Viscometric Properties Viscosity, centistokes, at:	35° F	1200 -	WO		
O paig	22	100° F	150° F	1	
3,000 paig	1	Ī	}		See NSRDL
5,000 paig]	ļ			Annapolis Report
8,000 paig	1				MATLAB 340
10,000 paig	1	ł			
15,000 paig	1	ĺ			1 -
20,000 psig	1				-
	ì	ļ	ļ		
	i				
		ļ			
		ŀ			
	[ĺ			İ
Viscosity, centistokes, at 100° F	7.68				
Viscosity, centistokes, at 210 F,	2.23				ASTM D-445
O paig]				
Viscosity Slope, ASTN	0.782	 			<u></u>
Lubricating Ability 4-Ball Wear Test, 30 min, 50° C.					n-4 w-12 2 6503
52100 stael, average scar dia.	ļ	!			Fed. Method 6503 (modified)
ma:		l			(moclifed)
l ka	ĺ	!			Ì _
3 kg					<u>-</u>
5 kg					
	1				
	1				
	ŀ				
	1	ŀ			
Corrosion Protection					
Stirred Rust Test, 10% Seawater,	•				ASTM D-665
140° F, 2 days					
On-Off Rust Test, 50% seawater,	ļ				See Chapter 2
150° F. 30 days	İ				Test C-5
Ambient Pressure, coupon				•	See Chapter 2
stirred, corrosion test, weight					Test C-1
change, mg Copper					
Stainless Steel, 316					-
Copper-Nickel (70-30)				l	1 -
Aluminum, QQ-A-250-4b	i				-
Phosphor-Bronze					1 -
Steel, galvanized	1				1 -
Steel, 1009	1				1 -
Aluminum, GQ-A-250-11					-
Bronze					-
Monel Silver Base Brazing Alloy					-
20,000 PSIG Pressure-Cycled			Į		See Chapter ?
Corrosion Test (1% seawater),	l		j		Test C-2
weight change, mg]				1
Insulated Specimens:	į.				
Copper	1		1		-
Stainless Steel, 316]				-
Copper-Wickel (70-50)			l		-
Aluminum, 00-A-250-46			ļ		-
Phosphor-Sxonze] -
Steel, gulvanized Steel, 1009			ļ		-
#tmer, 1009 #Aluminum, QQ-#A-250-11					
Bronze					_
- '	1	1	1		1
Mone l		1			1 -

	Method
Electrically Coupled Specimens:	
Copper-Aluminum, QQ-A-250-11	; •
Aluminum QQ-A-250-4b -	, "
Copper-Nickel (70-30)	ļ -
Mone 1 - Bronze	
Stainless Steel (516) -	
Phosphor-Bronze	! -
Silver Base Brazing Alloy -	
Steel, 1004	ļ -
Aluminum QQ-A-250-11 -	
Bronze	
Aluminum QQ-A-250-4b -	
Steel, 1009	
20,000 PSIG Stirred Corrogios	Sec Chapter ?
Test, weight change, mg	Test C-4
Insulated Specimens:	
Copper	1 -
Stainless Steel, 316	-
Copper-Nickel (70-30)	-
Aluminum, QQ-A-250-4b	-
Phosphor-Bronze	-
Steel, galvanized	-
Steel, 1009	-
Aluminum, QQ-A-250-11	-
Bronze	
Monel	•
Silver Base Brazing Alloy	-
Electrically Coupled Specimens:	į į
Copper-Aluminum, QQ-A-250-11	
Aluminum, QQ-A-250-4b -	-
Copper-Nickel (70-30) Monet-Bronze	
Stainless Steel (316) -	
Phosphor Bronze	
Silver Base Brazing Alloy -	
Steel, 1009	
Aluminum, QQ-A-250-11 -	
Bronze	
Aluminum, QQ-A-250-4b -	-
Steel, 1009	
Fump Test	Proposed military
Average Weight Loss, mg	specification for
Steel Gears	sea-water emuls:-
Bronze Bushings	fying oils
Corrosion Coupons, weight loss,	
each, mg/cm	ļ .
Copper	-
Aluminam	-
Steel, galvanized	-
Steel, 1009	-
Silver Base Brazing Alloy	ASTM D-1169 (mod-
Dielectric Properties	ified). See Chap-
Resistivity, F, Chm-cm:	ter 2. Test E-1
With Sea-Water Contamination:	Chapter 2
0.1% by volume	Test E-S
0.5% by volume	
2.0% by volume	
With Carbon Contamination:	Chapter 2
0.1% wt/vol.	Test E-6
0.25 wt/vol.	-
O Et at (m)	

	 	T	Mached
Disloutes Departing (Cont.)	•	1	Method
Dielectric Properties (Cont)		1	See Chapter 2
After 50,000 Electric Arcs	1	1 !	
(makes and breaks) at 90	Ĭ	1 1	Test E-7
volts, 10 amperes, resis-			
tive load	!		
Hot filtered		1	-
Filtered		1	-
Solids generated, gram	1	1	
Dissipation Factor, *F. %	1		See Chapter ?
As-Received	1	1	Test E-?
With Sea-Water Contaminations	ĺ		See Chapter 2
0.1% by volume	!]	Test E-5
• •	İ	1	1636 2-7
0.5% by volume	!		į -
2.0% by volume	İ		See Chapter 2
With Carbon Con'amination:	İ	1	Test E-6
0.10# wt/vol.	ļ		Test E-C
0.25% wt/vol.	l		-
0.50≸ wt/vol.	}		-
After 50,000 Blectric Arcs			1
(makes and breaks) at 90			
volts, 10 amperes, resis-	ļ		
tive load	ļ		
Mot filtered	ļ		<u>-</u>
Filtered	1		<u>-</u>
Solids generated, gram	1	1	_
Dielectric Breakdown Voltage,		1	ASTH D-877 (mod
0.05-inch gap, *F, Rv	i		ified), See Cha
As received	l		tel 2. Test E-
}	1	1	See Chapter 2
With sea-water contamination:	1	1 1	1
0.1% by volume	}	1	Test E-5
0.5≸ by volume	Į.	i	-
2.0% by volume	1		
With carbon contamination:	1		See Chapter 2
0.10# wt/vol.			rest E-€
0.25% wt/vol.	1		-
0.50≸ wt/vol.			-
After 50,000 electric area	j .	1	1
(makes and breaks) at 90	Ì	1 1	
volts, 10 amperes, resis-	1	;	
tive load			
Not filtered	1		1
1			-
Filtered	1		-
Solids generated, gram	Į.		-
Contact Life, silver-cadmium, 50			See Chapter ?
volts, 10 amperes, resistive			Test E-3
load, 6000 ps1, 65°-85° F	1		
Number of tests	i	!	-
Operations to failure (range)			
Emulsion Stability	ĺ		Ì
Paddle Test, after !-hour set-	i		AS #71 U=1401
tlings			
Oil, ml	!		_
Emulsion, ml	1		-
Water, ml	Ì	l j	
•	ì		See Chapter I
Electric Probe Yest, time for	ļ		Test 2-4
water separation, min			•
Material Compatibility Stacic 2007SI	i		See Chapter ?
Butyl			Test C-3
∄una X	i		-
Viton B			i -
Ethylene-Propylene	Ì		-
Tetrafluoroethylene (Teflon)	1		-
Heopress	1	1	* ·
Thickol	i i		-
Silicone	1	!	_
		, ,	

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			 	Method
Volatility	1	i		Hethod
Toxicity	Petroleu	1		
Density, grams/cubic centimeter, at:	35	100° F	<u> </u>	
O parq		+	 	See NSKOL
4,000 psig	1	1		Annapolis Repeat
5,000 parq		1		MATLAB 500
8,000 paig	ł	1		HATLAB /
10,000 paky	i	1		
1',000 pm.q				
1	1	}	1	1
20,000 pstq	35° E	100° F		
Isothermal Compressibility, volume	122	100 1	14.0 F	
decrease, %, Atı				See NSRDL
0 paig	ĺ	l .		Annapolis Punci
5,000 psig	Į	Į.		MATLAB 550
5,000 paig	l			
8,000 paig	j	1		
10,000 psig				
15,000 paig	1	Į	1	
20,000 paig		1	i	
Chemical Stability				
Oxidation Stability Test, 203° F,	1			ASTM D=)4.7
hours to failure	ļ]		
Oxidation Stability Test, 250° F	1	1		Fed. Method ' */ "
Hydrolytic Stability Test				Military specifi-
Specimen change, mg	J	}	i İ	cation MIL-H-
Specimen appearance	1	1		19457B
Fluid acid number increase,		1		-
mg MOH/gram fluid		1		
Water acidity, mg NOH	ŀ	1		<u>-</u>
Insolubles, \$	ĺ			_
Thermal Stability Test	1	1		-
Fire Resistance	j			
Flash Point, F	530			ASTM D
Fire Point, 'F	1 1/0	1		ASTM D-7
Automeneous Ignition Temperature, F		Ì		ASTM D=2104
High-Pressure Spray Combustor				See MEL Repairt
Minimum spontaneous ignition		1		51/66 of March
temperature, °F		i		1967
Minimum reaction temperature,	-	1		
• F	1	1		_
No indication of fire, "F				
Maximum pressure change, psi		1		
Lowest temperature of maximum				
pressure change, *F	İ	1		
Temperature range explored, °F		1		ļ
Miscellaneous ?roperties				1 -
Four Point, F	1]		ASTM D-)7
Foaming Tendency, 75° F	+15			ASTM D-897
Foam after 5-minute aeration,	1			ASIA D-OIL
ml	ĺ	1		-
: · · · · · · · · · · · · · · · · · · ·		i		
Time out, minutes Foam after 10 minute settling,	1			-
eoam arter loominute settling, ml	1	<u>,</u>		, ~
	1			3 C May 15 3 CT :
Neutralization Number, mg MOH/gram				ASTM D=374
Water Content, % by weight	1			ASTM D-1744
Meutrality, qualitative	i			Fed. Method 11.1
Contamination	1			-
Number and size of particles and	1			SAE Method AFP-
fibers in 100-mg fluid				508
25-100 aicrometers	İ	1		-
100-500 micrometers	1	1		-
over 500 micrometers				-
particles over 250 microm-		1		ļ -
oters except fibers (length	1			
ten times diameter	i	1		1
Gravimetric Value, mg/100 ml	!)	ļ	SAE Mothed ABra by
		i		
Color				ASTM D-15-5
Coet \$/qa!	1	from su	A	-
At a ; lab ; l 12 ý	propriet	Z,1	<u></u>	

Incrementations made to atmospheric pressure, unless noted.

Fluid Code L

Suggested Uses and Possible Limitations

Fluid Code L is a silicone oil containing an additive for improving lubrication. Laboratory wear measurements show that the additive has improved the lubricity when compared to a silicone of the same viscosity. However, the wear tests indicat that the lubricity of Code L is still not suitable for a motor or gear lubricant under deep submergence conditions. It affords no corrosion protection, and it is extremely flammable. Its initial dielectric properties are good. Because this product is a slight modification of MIL-S-21568A, 1-cs fluid, it should be a good second choice to the latter product for all electrical applications other than motors.

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Fluid Code L(1)

(Silicone Base Fluid)

Viscosity, Centistokes, at 1 Opasis Viscosity, Centistokes, at 100° F, 0.76 Viscosity, Centistokes, at 150° P, 0.44 Opasis Viscosity, Centistokes, at 150° P, 0.44 Opasis Viscosity, Centistokes, at 150° P, 0.44 Opasis Viscosity, Centistokes, at 150° P, 0.44 Opasis Viscosity, Centistokes, at 150° P, 0.44 Opasis Viscosity, Centistokes, at 150° P, 0.44 Opasis Viscosity, Centistokes, at 150° P, 0.44 Opasis Viscosity, Centistokes, at 150° P, 0.44 Opasis Viscosity, Centistokes, at 150° P, 0.44 Opasis I kg Opasis I kg Opasis I kg Opasis I kg Opasis I kg Opasis Opasis Opasis Corrosion Protection Stirred Rust Test, 10f seawater, 140° P, 20 days Ambient Pressure, coupon attirred, corrosion test, weight change, and Copper Stainless Steel, 316 Copper-Nickel (70-84) Phosphor-Bronze Steel, salvanized Seel, Johnstied Opasis	
Viscosity, centistokes, at 100 F 100	
Sign Sign	
3,000 paint 3,000 paint	
9,000 psi4 8,000 psi4 10	
8,000 psis; 10,000 psis; 10,000 psis; 15,00	
10,000 psis 10,000 psis	
Viscosity, centistokes, at 100° F. 0.76 Viscosity, centistokes, at 150° F. 0.44 O.76	
Viscosity, centistokes, at 100° F, 0.76 Viscosity, centistokes, at 150° F, 0.44 0.98 Viscosity, centistokes, at 150° F, 0.44 0.98 Viscosity, Slope, ASTM Lubricating Ability 4.8811 Mear Test, 0 min, 80° C, 5:100 steel, average scar dia., mm: 1 kg	
Viscosity Slope ASTM	
Usasity Slope, ASTM	
Viscosity Slope, ASTM	
Lubricating Ability	
### ### ##############################	
### ### ##############################	,
1 kg	
3 kg 5 k; 15 kg 30 min, 50° C, 5/100 steel 1 kg 60 min, 50° C, 5/100 steel, 1 kg Corrosion Protection Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Stiel, 316 Copper-Nickel (70-50) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, 1009 Aluminum, Q2-A-750-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight channe, mg Insulated Specimens: Copper	
Strred Rust Test, 10% seawater, 140° F, 2 days On-off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred; corrosion lest, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-36) Aluminum, 00-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, 02-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper	
15 kg 30 min, 50° C, 50100 steel 1 kg 0.26 0.40 60 min, 50° C, 50100 steel, kg 0.30 Stirred Rust Test, low seawater, 140° F, 2 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Stiel, 316 Copper-Nickel (70-30) Aluminum, 00-A-250-4b Phosphor-Bronze Steel, galvanized Sheel, 1009 Aluminum, Q2-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (14 seawster), weight channe, m; Insulated Specimens: Copper - 0.40 0.40 0.40 0.40 0.40 0.40 0.40 0.40	
30 min, 50° C, 50100 steel 1 kg	
Corrosion Protection Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 90 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-%) Aluminum, 00-A-250-4b Phosphor-Bronze Steel, 1009 Aluminum, 02-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
Corrosion Protection Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 50 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, 00-A-250-4b Phosphor-Bronze Steel, galvanized Sheel, 1009 Aluminum, Q2-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Stiel, 316 Copper-Nickel (70-30) Aluminum, 00-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, 02-A-250-11 Bronze Honel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, 00-A-250-4b Phosphor-Bronze Steel, galvanized Steel, galvanized Steel, 1009 Aluminum, Q2-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, 00-A-250-4b Phosphor-Bronze Steel, galvanized Steel, galvanized Steel, 1009 Aluminum, Q2-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
140° F, 2 days On-Off Rust Test, 507 seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-%) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, Q2-A-250-11 Bronze Honel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (17 seawater), weight change, m; Insulated Specimens: Copper - Sec Chapter Test C-7	
On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 3i6 Copper-Nickel (70-36) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Honel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper - Test C-1	
Change, mg Copper Stainless Steel, 316 Copper-Nickel (70-36) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, jalvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
Copper Stainless Steel, 316 - Copper-Nickel (70-36) - Aluminum, QQ-A-250-4b - Phosphor-Bronze - Steel, galvanized - Steel, galvanized - Aluminum, QQ-A-250-11 - Bronze - Monel - Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled - Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper - Copper	
Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Honel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Honel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Honel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, Q2-A-250-11 Bronze Honel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight channe, m; Insulated Specimens: Copper	
Sheel. 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper	
Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, m; Insulated Specimens: Copper -	
Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight chance, m; Insulated Specimens: Copper -	
20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), Weight chance, m; Insulated Specimens: Copper -	
Corrosion Test (1% seawater), Weight change, m; Insulated Specimens: Copper -	
Weight chance, m; Insulated Specimens: Copper -	
Insulated Specimens: Copper -	
Copper -	
Stainless Steel, 316	
Copper-Nickel (70-30) -	
Aluminum, QQ-A-255, 4-65	
Phosphor-Bronze -	
Steel, galvanized -	
Steel, 1'09 -	
Aluminur, 00-A-0'80-11	
Bronze -	
Monel	
Silver Base Brazing Ailoy	

			 		
2	ļ		ì	1	Method
Corresion Protection (Cont)	i	1	1		1
Electrically Coupled Specimens:		}		ł	1 -
Copper-Aluminum, QQ-A-250-11	1	i	i	}	1 -
Aluminum QQ-A-250-4b -	1		}	ŀ	-
Copper-Mickel (70-30)	l	i	Ì		ļ
Mone 1 - Bronze	l	ļ	1	ł	 -
Stainless Steel (516) -	l	ł .	j		1 ~
Phosphor-Bronze	l	ł	1	ł	ł
Silver Base Brazing Alloy -	!		l		} ~
Steel, 1004	1				<u> </u>
Aluminum QQ-A-250~11 -	}	1)	ļ] -
Bronze		ì			
Aluminum QQ-A-250-4b -	ł	ł	ł		-
Steel, 1009	<u> </u>	i	ł		
20,000 PSIG Stirred Corrosion	1	ł	1	}	See Chapter ? Test C-4
Test, weight change, mg	ļ	1	ļ	Į.	Test C-4
Insulated Specimens:	İ		•	1	
Copper	}	1	ł	l	-
Stainless Steel, 316	l		Į.	İ	-
Copper-Nickel (70-30))	}	}		-
Atuminum, QQ-A-250-4b	ĺ	i	<u> </u>	Ì	-
Phosphor-Bronze	ł	{	ì	l	-
Steel, galvanized		ł	ł		-
Steel, 1009	1		Í		-
Aluminum, QQ-A-250-1)	ļ]	Į	}	-
Bron.e		1			-
Monel	ł	ł	į	ł	-
Silver Base Brazing Alloy Electrically Coupled Specimens:	ļ	į.	l	ļ	-
	ì	1		į	
Copper-Aluminum, QQ-A-250-11	ļ		į	}	-
Aluminum, QQ-A-250-4b -			1]	•
Copper-Nickel (70-30) Monel-Bronze	ł	}	Į	į	
Stainless Steel (316) -		1	ł	!	-
Phosphor-Bronze		l			-
Silver Base Brazing Alloy -		Į.	l	1	_
Steel, 1000					_
Aluminum, QQ-A-250-11 -		i	i ·	·	_
Bronze		ł	}		1
Aluminum, QQ-A-250-4b -					_
Steel, 1009	1	}	Ì	1	
Pump Test			ĺ		Proposed military
Average Weight Loss, mg		Į		1	specification for
Steel Gears					sea-water emulsi-
Bronze Bushings		{	[fying oils
Corrosion Coupons, weight loss,		l	i i		Accept to TT
each, mg/cm ²		1			
Copper		[[-
Aluminum					-
Steel, galvanized			[_
Steel, 1009		ĺ	[_
Silver Base Brazing Alloy		1	!		-
Dielectric Properties		1			ASTM D-1169 (mod-
Resistivity, 76 °F, ohm-cm:		1]		ified). See Chap.
As-Received	5.0×10 ¹¹	1	i		ter 2. Test E-1
With Sea-Water Contamination:		<u> </u>] j		Chapter 2
0.1% by volume		! 1	ļ		- Test E-5
0.5% by volume		!]		-
2.0% by volume]		. •
With Carbon Contamination:					Chapter 2
0.1% wt/vcl.		ļ			- Test E-6
0.25% wt/vol.)		₩-
0.50					

Dielectric Properties (C nt)				1	Method
After 10,000 Electric Arcs	Į	i	1		See Chapter ?
(makes and breaks) at 90	ł		1	i	Test k-7
volts, 10 amperes, regis-	1	1	1		1.000 21
tive load	i	1	İ	1	
Not filtered		ì	ì	1	_
Filtered	ļ	1	1	1	1 -
Solids generated, gram	1	i	1		
Dissipation Factor, 76 📆, 🐒		ŀ	ļ	ļ	See Chapter ?
As-Received	0.9		1	1	Test 2-2
With Sea-Water Contamination:	1		Ì		See Chapter ?
0.1% by volume	1	1	1		- Test E-5
0.5% by volume		ì	ĺ	1	1 -
2.0% by volume	}	1))	1 -
With Carbon Contamination:		[See Chapter ?
0.10% wt/vol.	1	1	}	}	Test E-6
0.25% wt/vol.	1	i	1		-
0.50% wt/vol.		1	ļ		1 -
After 50,000 Electric Arcs	1		}	}	1
(makes and breaks) at 90		į	1		ł
volts, 10 amperes, resis-	1	1	1	1	
tive load Not filtered	i			1	1
Filtered	ł	1	ļ	1	-
	ļ		1	1	-
Solids generated, gram Dislectric Breakdown Voltage,	ļ	j		1	-
0.05-inch gap, 76 °F, kv	Ì	1	1		ASTM D-877 (mod-
As received	26.2	1	ì		ified). See Chap-
With sea-water contamination:	20.2	1	1	1	ter 2. Test E-3
0.1% by volume					See Chapter 2
0.5% by volume	ļ	1	1	1	Test E-5
2.0% by volume		1			-
With carbon contamination:	İ	1	1	1	
0.10% wt/vol.		ļ		į	See Chapter 2 Test E-6
0.25% wt/vol.	1	1	ļ		Test E-0
0.50% wt/vol.	-				
After 50,000 electric arcs		1	Ì		
(makes and breaks) at ≤೧			1		ĺ
volts, 10 amperes, resis-		l	1		[
tive load		1	1		ĺ
Not filtered		1	i		i -
Piltered		1	j		l -
Solids generated, gram	l	ı	I	}	i -
Contact Life, silver-cadmium, 50	J	J		1	See Chapter 2
volts, 10 amperes, resistive	İ	1	i		Test E-8
load, 6000 psi, 65°-85° F		1	ļ	1	
Number of tests	1	i	1	1	-
Operations to failure (range)	1	1	1	İ	
Rmulsion Stability Paddle Test, after i-hour set-	ĺ	1	i	i	3 cm 6 3503
tling:					ASTM D-1401
Oil, ml	40		l	}	
Emulsion, ml	40				-
Water, ml	40	}	1	1	_
Electric Probe Test, time for	"				See Chapter ?
water separation, min					Test E-4
Material Compatibility Static 20KPST	1		1		See Chapter ?
Butyl			1		Test C-3
Suna N		1	1		-
Viton B			I		_
Ethylene-Propylene		1	[~
Tetrafluoroethylene (Teflon)					-
Heoprene		1			_
Thiokol]			-
Silicone		!			-
Fluorosilicone		Ĺ			_

	1		T	T	Method
Volatility					-
Toxicity	Bilicone	1			-
Density, grams/cubic centimeter, at:	35° F	100 F	150° F		
0 paig				1	See NSRDL
3,000 paig			l		Annapolis Report
5,000 paig	ļ	l		1	MATLAB 350
8,000 paig		ł		1	1
10,000 paig		}			ļ
15,000 paig		ļ			
20,000 psig Isothermal Compressibility, volume	35° P	1000			
decrease, %, at:	22 1	100° F	150° F		a vansi
0 psig	1		1		See NSRDL
3,000 paig	ļ	ŀ	l .		Annapolis Report MATLAB 350
5,000 paig	•	İ			I
8,000 psig	ļ	1	1		
10,000 psig			ì		
15,000 paig					
20,000 psig		F			
Chemical Stability		· · · · · · · · · · · · · · · · · · ·	<u> </u>	· · · · · · · · · · · · · · · · · · ·	
Oxidation Stability Test, 203° F,					ASTM D-943
hours to failure	İ				
Oxidation Stability Test, 250° F					Fed. Method 5308
Hydrolytic Stability Test			İ		Military specifi-
Specimen change, mg	:				cation MIL-H-
Specimen appearance					19457D
Fluid acid number increase,					-
mg NOH/gram fluid				•	
Water acidity, mg KOH Insolubles, %					-
Thermal Stability Test	<u> </u>		·		-
Fire Resistance					-
Flash Point, °F					ASTM D-00
Fire Point, °F	ì	ĺ			ASTM D=42
Autogeneous Ignition Temperature, F					ASTM D-2155
High-Pressure Spray Combustor			i		See MEL Report
Minimum spontaneous ignition					31/66 of March
temperature, °F					1967
Minimum reaction temperature,					-
*P					
No indication of fire, °F	<u> </u>				-
Maximum pressure change, psi	i :				-
Lowest temperature of maximum			: 		-
pressure change, °F					
Temperature range explored, °F Miscellaneous Properties	!				-
Pour Point, P					ASTM D-97
Foaming Tendancy, 75° P					ASTM D-892
Foam after 5-minute aeration,	}				
ml					
Time out, minutes					_
Foam after 10-minute settling,	[-
ml			ì		
Meutralization Number, mg NOH/gram					ASTM D-974
Water Content, % by weight	0.030				ASTM D-1744
Heutrality, qualitative	•				Fed. Method 5101
Contamination			l		-
Number and size of particles and	 				SAE Method ARP-
fibers in 100-ml fluid			}		5 9 8
25-1CU micrometers					-
100-500 micrometers					-
over 500 micrometers					-
particles over 250 microm-					-
eters except fibers (length ten times diameter)					
Gravimetric Value, mg/100 ml					CAE Mothed ton
Greatmenting Astrice, mid-100 mi					SAE Method ARP - 789
Color	1				ASTM D-1500
	availahi	from sup	blier	·	-
Cost \$/gml		vrom anh	7**"		!

Determinations made at atmospheric pressure, unless noted.

Fluid Code M

Suggested Uses and Possible Limitations

Pluid Code M has a low viscosity which would indicate that it may be suitable for special requirements at great depths. Its wear test is rather good, indicating the possibility of favorable lubrication properties. It provides some corrosion inhibition. It has a low resistivity and a high dissipation factor, making it questionable for any electrical application at deep ocean pressure. It is highly flammable.

Fluid Code M(1). (Petroleum Base Fluid)

(Pet	roleum Bas	e Fluid)		
acception Brown tion				Method
cometric Properties Viscosity, centistokes, at:	35° ₹	100° F	150° F	
0 paig				
3,000 paig				See NSKDL
5,000 paig				Annapolis Repor
8,000 paig			i	MATLAB 350
10,000 paig] -
15,000 paig	l			-
20,000 paig	j] -
			ŀ	
Viscosity, centistokes, at 100° F,				
Viscosity, centistokes, at 210° F,	1.20			ASTM D-445
O paig	ا ا		1	
Viscosity Slope, ASTM	0.865			
bricating Ability				ma maka kid
4-Ball Wear Test, 60 min, 80° C,	ļ !		!	Fed. Method 650
52100 steel, average scar dia.,			i	(modified)
mm:			[_
40 kg	0.75		Į.	-
Stirred Rust Test, 10% seawater, 140° F, 2 days	Pass			ASTM D-665
140° F, 2 days On-Off Rust Test, 50% seawater,				See Chapter ?
Stirred Rust Test, 10% Seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° P, 30 days	Pass Fail			See Chapter ? Test C-5
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen				See Chapter ? Test C-5 See Chapter ?
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° P, 30 days Ambient Pressure, coupon stirred, corrosion test, weight				See Chapter ? Test C-5
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg	Fail			See Chapter ? Test C-5 See Chapter ?
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper	Fail -14.8			See Chapter ? Test C-5 See Chapter ?
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316	-14.8 + 0.3			See Chapter ? Test C-5 See Chapter ?
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30)	-14.8 + 0.3 - 1.1			See Chapter ? Test C-5 See Chapter ?
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316	-14.8 + 0.3 - 1.1 + 0.5			See Chapter ? Test C-5 See Chapter ?
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b	-14.8 + 0.3 - 1.1			See Chapter ? Test C-5 See Chapter ?
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze	-14.8 + 0.3 - 1.1 + 0.5 - 9.8			See Chapter ? Test C-5 See Chapter ?
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8			See Chapter ? Test C-5 See Chapter ?
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9			See Chapter ? Test C-5 See Chapter ?
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-il Bronze Monel	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ?
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9			See Chapter ? Test C-5 See Chapter ? Test C-1
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-il Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ? Test C-1
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-il Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater),	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ? Test C-1
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronse Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ? Test C-1
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens:	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ? Test C-1
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-il Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ? Test C-1
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-il Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Stainless Steel, 316	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ? Test C-1
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupon stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-il Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Stainless Steel, 316 Copper-Mickel (70-30)	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ? Test C-1
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Stainless Steel, 316 Copper-Mickel (70-30) Aluminum, QQ-A-250-4b	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ? Test C-1
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Stainless Steel, 316 Copper-Mickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ? Test C-1
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Stainless Steel, 316 Copper-Mickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ? Test C-1
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-il Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Steinless Steel, 316 Copper-Mickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, galvanized Steel, 1009	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ? Test C-1
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Stainless Steel, 316 Copper-Mickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ? Test C-1
Stirred Rust Test, 10% seawater, 140° F, 2 days On-Off Rust Test, 50% seawater, 140° F, 30 days Ambient Pressure, coupen stirred, corrosion test, weight change, mg Copper Stainless Steel, 316 Copper-Nickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-il Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater), weight change, mg Insulated Specimens: Copper Steinless Steel, 316 Copper-Mickel (70-30) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, galvanized Steel, 1009	-14.8 + 0.3 - 1.1 + 0.5 - 9.8 - 6.8 + 0.2 - 0.6 - 7.9 - 1.5			See Chapter ? Test C-5 See Chapter ? Test C-1

				T	Method
Corrosion Protection (Cont)	ł		1	I	
Electrically Coupled : pecimens:	ı		1	1	-
Copper-Aluminum, UN-A-250-11	1	ſ	1	1	-
Aluminum QQ-A-250-4b -	1	ļ		1	-
Copper-Nickel (70-30)	ļ	1	ļ	İ	1
Monel-Bronse	1	j	1	1	-
Stainless Steel (516) -		1	1		-
Phosphor-Bronze	!	1		1	
Silver Base Brazing Alloy -					-
Steel, 1004	ł	1	1	1	
Aluminum QQ-A-(1-0-11 -	J)	1	}	} -
Bronze	1		1		
Aluminum QQ-A-250-4b -	l				-
Stee!, 1009			i		
20,000 PSIG Stirred Corrosion	[1	Į.		See Chapter 2
Test, weight change, mg		1	1		Test C-4
Insulated Specimens:	1	J	•		j
Copper	1	Ì			-
Stainless Steel, 316	ŀ		1	ŀ	-
Copper-Nickel (70-30)	ļ	İ	i] -
Aluminum, QQ-A-050-4b	1				-
Phosphor-Bronze		1	1		-
Steel, galvanized]	1	1	j] -
Steel, 1009					-
Aluminum, QQ-A-250-11	1	1			-
Bronze	}	j	1		 -
Hone l	•	1		İ	-
Silver Base Brazing Alloy	1	1	1		-
Electrically Coupled Specimens:	.ł	ļ	1		
Copper-Aluminum, QQ-A-250-11	.[[-
Aluminum, QQ-A-250-4b -	1		1	1	-
Copper-Nickel (70-30)	1	!	1		
Monel-Bronze		f .	ĺ	1	-
Stainless Steel (516) -			1		-
Phosphor-Bronze	Ì			1	
Silver Base Brazing Alloy -	ł	1	1		-
Steel, 1009	l		i		
Aluminum, QQ-A-250-11 -	1		ļ		-
Bronze	1	1			
Aluminum, QQ-A-250-45 -	l	1	1	ì	-
Steel, 1009	ļ	j]	
Pump Test	j	1	-	1	Proposed military
Average Weight Loss, mg	1		1		specification for
Steel Gears	1	ļ		İ	sea-water emulsi-
3ronze Bushings	ļ	1		}	fying oils
Corrosion Coupons, weight loss,	İ	-		<u> </u>	
each, mg/cm ²	1	1	1		
Copper		[ĺ		~
Aluminum			Ì		-
Steel, galvanized		j]	-
Steel, 1009	i				_
Silver Base Brazing Alloy		Ì	1		-
Dielectric Properties	4	1	1	[ASTM D-1169 (mod-
Resistivity, 77 F. ohs-cm:	2.8×10 ³		1	Į	ified). See Chap-
As-Received	i	1			ter 2. Test E-1
With Sea-Water Contamination:	i			{	Chapter 2
0.1≸ by volume	1	1	1	•	- Test E-5
0.5% by volume	ł	1	1	į	· ·
2.0≸ by volume	1	i	1	ĺ	·
With Carbon Contamination:	1	1	1		Chapter 5
0.1% wt/wol.	1		1	Į	- Tear E-
0.25% wt/vol.	ĺ	1	1		-
0.5K wt/wn1	1	i	•		

	· · · · · · · · · · · · · · · · · · ·	-			
		1	1		Method
Dielectric Properties (Cont)	1				
Atter 50,000 Electric Arcs	1		[See Chapter 2
(makes and breaks) at 90	ł	ľ	i		Test E-7
	i	i	ı		Test E-1
volts, 10 amperes, resis-	ŀ		i		
tive load	J	J	1	J	ļ
Not filtered	1	1	1		1 _
Filtered			1	}	1
		1	{		1 -
Solids generated, gram	ļ	1	1	1	1 -
Dissipation Factor, 77 °P. \$		1			See Chapter ?
As-Received	>60	1			Test E-2
With Sea-Water Contamination:	1	1	ł	1	See Chapter 2
•	1	1	ì		•
0.1% by volume	ŀ	1			_ Test E-5
0.5% by volume	J	J	J	j) -
2.0% by volume	i				
With Carbon Contamination:				ļ	See Chapter 2
0.10% wt/vol.	1			1	Test E-6
1	1	1	1	ļ	Terc 2-0
0.25% wt/vol.	1			}	-
0.50% wt/vol.	ì	i		ł	-
After 50,000 Electric Arcs	1	1	1	1	
(makes and breaks) at 90	!	Í	I	ſ	1
	1		1	1	1
volts, 10 amperes, resis-	i	i	I	1	1
tive load	1	1	1	i	1
Not filtered	1	i	1		1 -
Filtered	1	1	1	1	_
Solids generated, gram		1		1	,
7	l	ı	1	1	000
Dielectric Breakdown Voltage,	i	1	1	1	ASTM D-877 (mod-
0.05-inch gap, 77 °F, kv	ł	1			ified). See Chap-
As received	20.6	1	1		ter 2. Test E-3
With sea-water contamination:		1	f	ĺ	See Chapter 2
0.1% by volume	1	i	ŀ		Test E-5
	ļ	Į.	1		Test E-5
0.5% by volume		ł		1	-
2.0% by volume				1	1 -
With carbon contamination:	1	1			See Chapter 2
0.10% wt/vol.	i	İ		1	Test E-6
		İ	1	Ì	I CRC E-C
0.25% wt/vol.	1	· ·			ļ -
0.50% wt/vol.	ļ	j.	J		J - j
After 50,000 electric arcs		Ì			<u> </u>
(makes and breaks) At 90		ł			
volts, 10 amperes, resis-		1			1
,	ł	1	ł	1	1
tive load		İ	ļ	ļ	
Not filtered] -
Filterec]		i		_
Solids generated, gram	1				1
Contact Life, silver-cadmium, 50	l		i		
•	ļ		1		See Chapter 2
volts, 10 amperes, resistive	Į.	l	1		Test E-3
load, 6000 psi, 65°-85° F	1	1]		
Number of tests	1	1	1	1	-
Operations to failure (range)	İ	1	ĺ	ľ	1
	1	I			į l
Emulsion Stability	1	1	i	1	
Paddle Test, after 1-hour set-	i	ļ	ţ	1	ASTH D-1401
tling:	1	1		1	:
Oil, ml	32	[ł	1	_
Emulsion, ml	23			1	
		1		Į.] -
Water, ml	25	1		1] -
Electric Probe Test, time for		•	ł		See Chapter 2
water separation, min	1			1	Test E-4
Material Compatibility Static 20KPSI	1				See Chapter 2
Rubber swell, *, 158° r, 168 hr.	1		1	Į.	· · · · · · · · · · · · · · · · · · ·
	İ	}		Î	Test C-3
Butyl Buna N - L stock	21.1	í		ĺ	! -
	1				-
Buna H - H stock	8.1	l		<u> </u>	<u>-</u>
Viton B				ł	
#thylene-Propylene Tetrafluoroethylene (Teflon)				İ	-
				İ	-
Neoprene Thi≎kol				!	1 - 1
Thickol Silicone		İ			-
fluorosilicone				İ	_
	L	<u> </u>		L	<u> </u>

^{*} Based on atmospheric pressure data.

Volat:lity	[l i	1	Method
Theicity	1]	į	j -
Density, grams/cubic centimeter, at:	Patroleu	100° F	150° F	
0 paig	-			See NERDL
5,000 paig	1	1		Annapolis Report
5,000 paig	1	1	}	NATLAB 350
8,000 paig	1	1	į į	12.72.2
10,000 paig	1	(ł
15,000 paig	1	1 1	1	}
20,000 peig		1 1	1	,
Isothermal Compressibility, volume	35	100° V	" DO'F	
decrease, 5, at:				See MSRDL
C parg	1] }	}	Annapolis Report
3,000 pelg	1])	}	MATLAB 350
5,000 paig	1	1	1	
8,000 berd	1	1 1	}	}
10,000 pmig	i i	1 1	1	
15,000 paig	1	1		}
20,000 paiq		1	Ì	i i
Chemical Stability				
Oxidation Stability Test, 205° F.	Satisfact	EV	1	ASTH D-945
hours to failure	1	[]	1	1
Oxidation Stability Test, 250° F	1	1 ([Fed. Hethod 5:08
Hydrolytic Stability Test	1)	į	Military specifi
Specimen change, mg			į.	cation Mil-H-
Apecimen appearance	}	1	\	19457B
Pluid acid number increase,				194016
mg MDM/gram fluid	1			1
Water ecidity, my MOH	1			1
Insolubles, \$		1	1	-
Thermal Stability Test	1	ì	ļ	-
Fire Resistance	, ,	1		\ -
Flash Point, 'P	215		Į	ASTM D=97
Fire Foint, 'P	220			1 '
Autogene us Ignition Temperature. F		1	ļ	ASTM D-):
High-Pressure Spray Combustor	} }		j	ASTM D-2155 See MEL Report
Minimum spontaneous ignition	1			31/66 of March
temperature, 'F	1 1		j	1967
Minimum reaction temperature.	1			1907
• 7				~
no indication of fire, "?	}	}		
Maximum pressure change, pa-	1	1		\ *
Lowest temperature of maximum	1	. }	1	ļ -
pressure change, 'F	}		1	ļ -
Temperature range explored, 'F	}	1	1	,
Miscellaneous Properties	1) -
Four Point, P	€-90	}		3000 0 311
Founing Tendency, 75° F	1	}	}	ASTH D-17
Poss after 5-minute heration.	1	{	1	ASTM 0-897
Total areas painting delaction,	}	į		-
Time out minutes	1	1		
Time out, minutes Foam after 10-minute settling,	1 1	i		} -
#1	1	1	1	-
	0.03	{	-	1
Westralization Number, my NDH/gram Water Content, 5 by weight	1 1	ŀ	į	ASTH 0-974
	0.035	1	į	ASTM 0-1744
Houtrality, qualitative Contamination		[Į Į	Fed. Nethod 101
	1 1	1	Į	l -
Number and size of particles and	₹ {	i		SAE Nethod ARF-
fibers in 100-al fluid	1		1	598
25-100 micrometers		ļ	ļ	(-
100-500 micrometers		-	ļ	-
over 500 micrometers	1	ļ		-
particles over 250 microma		ļ	1	-
eters except fibers (length	1 1	Ì	•	
ten times diameter)		}		•
Gravimetric Value, my/100 ml	1	i	į	SAE Method ARP - 75
Specific gravity at 70/60 'F	7.856	į	{	ASTN D-1298
Color	1)	1	ASTH 0-1500
Cost 3/gal	everiable		lier	-
wallability	proprieta	rv	}	;

Inscendinations made at atmospheric pressure, unless noted.

Fluid Code N

Suggested Uses and Possible Limitations

Fluid Code N is a sea-water-compatible/water-glycol-type hydraulic fluid and lubricant. Its viscosity is high, but since it has a water base it is possible that pressure would increase the viscosity by only a small amount. It provides fair lubrication for all conditions except rolling contact. It provides some corrosion protection. It will be unsuitable for any electric application at deep ocean pressure since its water base gives it unsuitable dielectric properties. It is fire resistant in spite of its low flash point since it will cease to burn when the source of ignition is removed.

Fluid Code #(1)

(W	ster-Glycol	Type Flu	14)	
/incomparing Bushamata	T		T	Method
Viscometric Properties Viscomity, centistokes, at:	35* •	100° F	11.00 E	
O paig	22 7	100 7	1	
3,000 paig			1	See MSRDL
5,000 paig				Annapolis Resert
8,000 paig	[Í	HATLAS 350
10,000 paig				-
15,000 peig 20,000 peig				•
20,000 paid				-
	1		j	
	i		•	
	l			
	!			
Viscosity, centistokes, at 100° P	67.3			
Viscosity, centistokes, at 150° P.	28			ASTH D-444
0 paig	[
Viscosity Slope, ASTN	0.533			
Abbil Mear Test, 50 min, 50° C,				
52100 steel, average scar dia.,	 			Sed. Method 6414
ma:				(modified)
l kg		i		
3 kg	1 1			-
15 kg	0.81			-
	1 1			
				İ
	1			
Stirred Rust Test, 10% vemmater,			i	
140° F. 2 days	Page	ĺ		ASTM D=6(5)
On-Off Rust Test, 50% seawater,	1	l	ĺ	See Chapte: ?
140° F, 50 days	Paul	!	1	Test C-5
Ambient Pressure, coupon	1			See Chapter ?
stirred, corresion test, weight	1 1			Test C-1
change, mg	Į .	į	Ī	,
Copper Stainless Steel, 316			ļ	
# rectitem # 3 (48 f) 10	+ 3.0	real, alcaemp deservad	To the comments of the comment	-
	+ 0.5	Peril, addamen dayayay ta sebas	Page 2 community symbols, and	-
Copper-Mickel (70-50) Aleminum, QQ:A-250-4b		rem. Adamsy dan vogen semanai di se	Parent of the control	-
Copper-Mickel (70-50)	+ 0.5	rom. Adamsey de syncy in syntame did rim	Term . The company of the company of	-
Copper-Wickel (70-50) Aluminum, QQ A-250-Ab Phosphor-Bronze Steel, galvanized	+ 0.5 + 1.3 + 1.4	To A. Address; discussion in consequent of the same and an actual section of the same and actual section of the same actual section		-
Copper-Wickel (70-50) Aluminum, QQ A-250-Ab Phosphor-Bronze Steel, galvanized Steel, 1009	+ 0.5 + 1.3 + 1.4 - 3.3 - 6.0 -452.4	to A. Assessory described in transmission for the contract of		
Copper-Mickel (70-50) Aluminum, QQ-A-250-Ab Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11	+ 0.5 + 1.3 + 1.4 - 3.3 - 6.0 -452.4 - 0.7	to Annual strategy described to the strategy described ton the strategy described to the strategy described to the strateg	The Total Commission with the second control of the second control	
Copper-Mickel (70-50) Aluminum, QQ-A-250-Ab Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze	+ 0.5 + 1.3 + 1.4 - 3.3 - 6.0 -452.4 - 9.7 + 3.2		The Total Commission and the party analysis of the commission of t	
Copper-Wickel (70-50) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel	+ 0.5 + 1.3 + 1.4 - 5.3 - 6.0 -452.4 - 3.7 + 3.2 + 1.1		The Total Company of the party analysis of the company of the comp	
Copper-Wickel (70-50) Aluminum, QQ-A-250-Ab Ploaphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronza Honel Silver Base Brazing Alloy	+ 0.5 + 1.3 + 1.4 - 3.3 - 6.0 -452.4 - 9.7 + 3.2		The Company of the party angles of the company of t	
Copper-Wickel (70-50) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel	+ 0.5 + 1.3 + 1.4 - 5.3 - 6.0 -452.4 - 3.7 + 3.2 + 1.1		The Commission of the process of the commission	See Chapte:
Copper-Mickel (70-50) Aluminum, QQ-A-250-Ab Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monal Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled	+ 0.5 + 1.3 + 1.4 - 5.3 - 6.0 -452.4 - 3.7 + 3.2 + 1.1		The Company of the party analysis of the company of	
Copper-Wickel (70-50) Aluminum, QQ-A-250-Ab Phospher-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Honel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater);	+ 0.5 + 1.3 + 1.4 - 5.3 - 6.0 -452.4 - 3.7 + 3.2 + 1.1		The Company of the part angle of the company of the	See Chapte:
Copper-Wickel (70-50) Aluminum, QQ-A-250-4b Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Twat (1% seawater); weight change, mg Insulated Specimens; Copper	+ 0.5 + 1.3 + 1.4 - 5.3 - 6.0 -452.4 - 3.7 + 3.2 + 1.1		The Company of the party management of the company	See Chapte:
Copper-Mickel (70-50) Aluminum, QQ-A-250-Ab Phospher-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Twat (1# seewater); weight change, mg Insulated Specimens: Copper Stainless Steel, 716	+ 0.5 + 1.3 + 1.4 - 5.3 - 6.0 -452.4 - 3.7 + 3.2 + 1.1		The Company of the party analysis of the second control of the sec	
Copper-Mickel (70-50) Aluminum, QQ-A-250-Ab Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Twat (1# seewater); weight change, mg Insulated Specimens; Copper Stainless Steel, 716 Copper-Mickel (70-30)	+ 0.5 + 1.3 + 1.4 - 5.3 - 6.0 -452.4 - 3.7 + 3.2 + 1.1		The for the property of the p	See Chapte:
Copper-Mickel (70-50) Aluminum, QQ-A-250-Ab Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monal Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater); weight change, mg Insulated Specimens; Copper Stainless Steel, 716 Copper-Mickel (30-30) Aluminum, QQ-A-250-4b	+ 0.5 + 1.3 + 1.4 - 5.3 - 6.0 -452.4 - 3.7 + 3.2 + 1.1		The Construction of the principle Construction of the state of the sta	See Chapte:
Copper-Mickel (70-50) Aluminum, QQ-A-250-Ab Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monal Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater); weight change, mg Insulated Specimens; Copper Stainless Steel, 716 Copper-Mickel (30-50) Aluminum, QQ-A-250-4b Phosphor-Bronze	+ 0.5 + 1.3 + 1.4 - 5.3 - 6.0 -452.4 - 3.7 + 3.2 + 1.1		The Constraints of the second	See Chapte:
Copper-Wickel (70-50) Aluminum, QQ-A-250-Ab Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, 20-A-250-11 Bronze Honel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater); weight change, mg Insulated Specimens; Copper Stainless Steel, 716 Copper-Wickel (70-30) Aluminum, QG-A-270-4b Phosphor-Bronze Steel, galvanized	+ 0.5 + 1.3 + 1.4 - 5.3 - 6.0 -452.4 - 3.7 + 3.2 + 1.1		The Case companies and subject to a substitution of the substituti	See Chapte:
Copper-Wickel (70-50) Aluminum, QQ-A-250-Ab Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Twat (1% seawater); weight change, mg Insulated Specimens; Copper Stainless Steel, 716 Copper-Wickel (70-30) Aluminum, QQ-A-276-4b Phosphor-Bronze Steel, galvanized Steel, 1009	+ 0.5 + 1.3 + 1.4 - 5.3 - 6.0 -452.4 - 3.7 + 3.2 + 1.1		The Case Company of the Case o	See Chapte:
Copper-Wickel (70-50) Aluminum, QQ-A-250-Ab Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, 20-A-250-11 Bronze Honel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater); weight change, mg Insulated Specimens; Copper Stainless Steel, 716 Copper-Wickel (70-30) Aluminum, QG-A-270-4b Phosphor-Bronze Steel, galvanized	+ 0.5 + 1.3 + 1.4 - 5.3 - 6.0 -452.4 - 3.7 + 3.2 + 1.1		The Case I was been been been been been been been bee	See Chapte:
Copper-Wickel (70-50) Aluminum, QQ-A-250-Ab Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11 Bronze Monel Silver Base Brazing Alloy 20,000 PSIG Pressure-Cycled Corrosion Test (1% seawater); weight change, mg Insulated Specimens; Copper Stainless Steel, 716 Copper-Wickel (70-30) Aluminum, QQ-A-250-45 Phosphor-Bronze Steel, galvanized Steel, 1009 Aluminum, QQ-A-250-11	+ 0.5 + 1.3 + 1.4 - 5.3 - 6.0 -452.4 - 3.7 + 3.2 + 1.1		The Case Indiana Property Section (Control of Section 1988) and the Case Indiana Section (Control of Section 1988) and th	See Chapte:

	T	T	7		1
Corrosion Protection (Cont)			i	1	Sp. Ch. 1
"lectrically coupled Sper mation					1
					-
Copper-Aluminum, vo A-2:0-11	1	1	ł) -
Aluminum QQ-A-(10-4) -	!		i		-
Copper-Nickel (70.40)	1		{		1
Monel-Bronze		1		İ	-
Stainless Sieel (416) -	1		1	İ	-
Phosphor -Pronze		1			1
Silver Base Bracing Alloy -	1		1		1 -
Steel, 1004	i			į	1
Aluminum VI-A-I C-11 -	1				1
Bronze	ł	ł	1	1	[-
Aluminum QU-A-010-4b -	ļ	1	1		ł
i		1			-
steel, 100)		İ		i	
20,000 PSIG Strived Carros, n	1	1	ļ		Sec Charte
Test, weight charma, ray			i		Test C-5
Insulated Specificasi	!		1		1
Copper		1	1		-
Stainless Steel, 516	i	1			l -
Copper-Nickel (70-50)	1				1 -
Aluminum, W-A-250-4b	1	i			-
Phosphor-Bionge	I	l	1	1	
Steel, palvanized	1	1			j -
Steel, 1900	l	1	1	i	~
Aluminum, w2-A-: (0-11	l		1		1 -
	1		1	1] -
Bronze	1			į	-
Mone l	1				-
Silver hase Brazing Alloy	1	į	1		-
Electrically Coupled Specimens:	İ]
Copper-Aluminum, QG-A-240-11		1			! -
Alumin in, WA-A-Cit-4b -			i		1 -
Copper-Nickel (?C-*C)	!				
Honel-Bronze	!	l		1	1 _
Stainless Steel (*16) -	ĺ		i	ł	} -
Phospher-Bronze	•	1]		[-
Silver Base Brazing Alle -	Ì	1	1		
•		İ	İ		-
Steel, 1009	į	ļ	1		}
Aluminum, wq-A-fit-li-	•				j -
Bronze	1	1			1
Aluminum, yu-A-The-bb-	1	i			-
Stecl, 1009					ļ
Pump Test	[-	1		Proposed militin
Average Weight Loss, my		•			specificati n
Steel dears	8.1				sea-water e al
Bronze Bushings	35.1	Ì		1	fying cils
Corrosion Coupons, weight less,	77.1	1	l	1	, -, -, -, -, -, -, -, -, -, -, -, -, -,
each, mg/cm²		i	1		<u> </u>
Copper					
• •		1		l	-
Aluminum		-			-
Steel, galvanized		1	1	1	-
\$tee1, 1009					_
Silver Base Brazing Allay		1			-
Dielectric Properties		1		İ	ASTH 0-1159 (
Resistivity, F, ohm-cm:		t	ì		ified). No object
As-Received		•		!	te: 7. Test E. !
With Sea-Water Contamination:			1		Chapter ?
C.1≸ by volume			j		Test E-
0.5€ by volume			1		itat a-
2.0% by volume		1	•		=
With Carbon Contamination:		[
		•	ř E		Chapter 2
C.E. we vo:		1			Test E-6
O.25€ wt/vol.		İ			-
0.5% mt/vol.		<u></u>	L		-

		Method
Dielectric Properties (Con.		
After 50,000 Electric Arcs		See Chapter
(makes and breaks) at 90		Test E-7
volts, 10 amperes, resis-	1 1 i	
tive load		
Not filtered		
Filtered	1 !	
Solids generated, plum Dissipation Factor, *F, 6		See Chapter
As-Received	1 1	Test b-1
With Sea-Water Contamination;		See Chapter :
0.1% by volume		Test E-
0.5% by volume		
2.0% by volume		
With Carbon Contamination:		See Chaptor 2
0.10% wt/vol.		Test E-r
0.25% wt/vol.		
0.50% wt/vol.		
After 50,000 Electric Arcs		į l
(makes and breaks) at 90		
volts, 10 amperes, resis-		1
tive load		
Not filtered		-
Piltered		-
Solids generated, gram		
Dielectric Breakdown Voltage,		ASTH D-877 /m/4-
0.05-inch gap, *F, kv		ified). See Chap-
As received		ter 2. Test E-5
With sea-water contamination:		See Chapter ?
0.1≸ by volume		Test E-1
0.∰ by volume		-
2.0% by volume		
With carbon contamination:		See Chapter ?
0.10% wt/vol.		Test E-6
0.25# wt/vol.		~
0.50% wt/vol.		-
After 50,000 electric arcs		
(makes and breaks) at 90		
volts, 10 amperes, revis- tive load		
Not filtered		
Piltered		
Solids generated, gram		
Contact Life, milver-cadmium, 50		See Chapter 7
velta, 10 amperes, resistive		Tesc E-3
load, 6000 psi, 65°-85° F		
Number of tests		j
Operations to failure (rang.)		
Emulsion Stability		
Paddle Test, after 1-hour set-		ASTK D=1401
tlings		
Cil. ml		-
Emulsion, ml		-
Water, ml		-
Electric Frobe Test, time for		Yee Chapter 1
water separation, min		Test E-4
Material Compatibility Static COKPS	1	See Chapter 1
Buty	Good	Test (-3
Burra H	Good	-
Viton B	G∞d .	-
Ethylone-Propylehe	Good	;
Tetrafluoroethylene (Tefion)	Good	-
Weoprene	Fair -Good	-
Thickel	-	-
51licone	7001	1 -
31110.414	1021	\$

	Pass	T	r —	Method
Volatility	Water			-
Toxicity	Glycol		LL	
Density, grams/cubic centimeter, at:	25	100 F	150 1	
C paig		I		See NSRDL
3,000 paig			l i	Annapolis Report
5,000 paig	1		}	HATLAB 5' ∨
8,000 paig				
10,000 paig		1		ł
15,000 paig	1	1	1	
20,000 psiq Isothermal Compressibility, volume	350 F	100° F	150° F	
decrease, %, at:	75	100 -		See NSRDL
0 paig	1			Annapoli: Resear
3,000 paig	1			MATLAB "%
5,000 paig		1		
8,000 psig		1		
10,000 paig	1	1		
15,000 paig	1	1		1
20,000 paig		l	i	
Chemical Stability				
Oxidation Stability Test, 203° P,	1	Ì		ASTH D=94.*
hours to failure	ł	1		
Oxidation Stability Test, 250° F		1		Fed. Kethod 120
Hydrolytic Stability Test				Military specif.
Specimen change, mg		0.02		cation MIL-H-
Specimen appearance	ĺ	Batisfacto	ry	1945.7B
Fluid acidity pH		9.8		-
Insolubles, \$		nil		1
	· ·	1		
. Thermal Stability Test	1	1	İ	_
Fire Resistance	1			
Plash Point, P	265	1		ASTM D-92
Fire Point, °F	270	1		ASTM D-9
Autogeneous Ignition Temperature,		1	İ	ASTM D-2155
High-Pressure Spray Combustor	025			See MEL Report
Minimum spontaneous ignition	500	1		51/66 of March
temperature, °F	J.,,			1967
Minimum reaction temperature,	460			-
° ₹				
No indication of fire, °P	450			 -
Naximum pressure change, psi	200	1		-
Lowest temperature of maximum	560	1		-
pressure change, *F	1			
Temperature range explored, "F	\$50-560			-
Miscellaneous Properties	-			_
Pour Point, P	-:0	1		ASTM D-17
Forming Tendency, 75° F	00-	1		ASTM 0-897
Poam after 5-minute aeration,	2 8 0			-
ml	1	}		
Time out, minutes Poam after 10-minute settling,	4	1		1]
roam arter 10-minute settling, ml	0	i		-
Bestralization Number, mg KOH/gram	. 1	1		ASTM D-77%
Water Content, % by weight	· [ASTM D-17-4
Neutrality, qualitative		1		Fed. Method '101
Contamination	Ī	1		-
Number and size of particles an	a	1		SAE Method ARP-
fibers in 100-m1 fluid	ļ.	-		598
25-100 micrometers	•	1		-
100-500 micrometers	į			-
over 500 micromoters				! -
particles over 250 microm-	I	1		-
eters except fibers (length	.]			!
ten times diameter)		1		
Gravimetric Value. mg/100 ml	İ	1		SAE 5 Clad ARP=
	1			78"
Color	1			ASTM 0-1500
Cost 1/71		from sup	lier	-
Availability	Propriet	ıtv	; l	ļ -

Determinations made at atmospheric pressure, unless noted.

Pluid Code N

1			
Ì			Method
	Material Compatibility with		See Chapter 2
			Test C-3
	Natural Rubber	Pair	
	Polyurethane	Po or	i i
	· •		ļ

^{*} Based on atmospheric pressure data.

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